HANDLING BALES OF cotton IN PUBLIC WAREHOUSES

Methods and Equipment

Marketing Research Report No. 250

Agricultural Marketing Service
Marketing Research Division
U. S. DEPARTMENT OF AGRICULTURE

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By Ja Brice Wilmeth and
Charles D. Bolt

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CONTENTS

SUMMARY

The purpose of this report is to help to hold down the cost of marketing cotton, by pointing out to warehousemen ways in which they can increase operating efficiency and reduce the cost of bale handling. The studies on which the report is based are part of a nationwide program of research designed to improve efficiency and cut costs in marketing farm products.

The biggest operating expense in warehousing cotton is that for physical handling of the bales. Bales are handled many times in moving them into, within, and out of the warehouse. When they arrive at the warehouse, they are unloaded, weighed, sampled, transported to the storage area, and stored; on receipt of shipping orders, they are broken out of storage, transported to a loading area, and loaded into cars and trucks. Other handling, such as that required when bales are compressed, may also be involved. In warehouses, some of these jobs are done mainly by hand, others by powered handling equipment, and still others by a combination of machine and manual methods. Warehousemen can do this handling at lowest cost only by using the most efficient equipment and methods for each type of operation.

A primary consideration in the selection of handling equipment, therefore, is its efficiency. The equipment that gets the job done with the least labor is the most efficient. A second consideration is the ownership and operating cost of the equipment itself. In determining the lowest cost method of handling, direct labor and equipment costs must be considered. A third consideration in choosing equipment is the ability of the equipment to get the job done within the time available. Speed in handling and low cost usually, though not always, go together. Still another consideration is the adaptability of the equipment to different types of handling operations.

The equipment that has most satisfactorily met the requirements of efficiency, economy, speed, and versatility, as well as other requirements in handling cotton in warehouses, is the powered industrial lift truck. Lift trucks equipped with bale clamps become efficient transporters, loaders, unloaders, and stackers. The relative efficiency of these clamp trucks for the different operations varies according to the type and size of truck. Most trucks currently in use have a 2-bale capacity; others handle 3, 4, or 6 bales at a time. With other attachments, certain sizes of trucks can be used efficiently in breaking out bales from stacks, weighing, and other operations. Where the total number of bales handled by a warehouse during a season is large enough, trucks varying in size and in type of attachments may be used for different operations. This permits the use of the most efficient equipment in each operation. In most warehouses, however, several types of operations must be performed by the same equipment. For such use, 2-bale and 3-bale trucks have proved best in many smaller warehouses. In some of the larger plants, especially where cotton is received and shipped by road truck, the 4-bale industrial clamp truck has shown itself to be a good general-purpose machine.

Different operations may require different equipment. In loading and unloading railroad cars, only 2-bale clamp trucks can be used for flat bales, but 3-bale trucks can be used for compressed bales. In loading and unloading road trucks, however, 2-, 3-, 4-, and, under some circumstances, 6-bale trucks can be employed. Transporting over long distances is done most efficiently by 4- and 6-bale trucks. Stacking is most efficiently done by clamp trucks; but breaking out usually must be done by boom trucks, if from a cordwood type of stack, or by trucks equipped with breakout devices, if from an on-head stack. This breakout device substantially reduces the cost of breaking out.

The most efficient methods for weighing flat bales employ mobile scales, while compressed bales usually are best handled with portable platform scales. Indications are, however, that with continued improvement, mobile weighing equipment and accessories will be used to an increasing extent in weighing both compressed and flat bales.

Sampling is the one remaining operation still mainly performed by hand. Cutting, pulling, trimming, wrapping, and sacking of samples are essentially hand operations. Sampling is best improved, then, by improving the method of sampling, rather than the equipment. Of the methods used, block sampling has proved most efficient, for both flat and compressed bales.

The efficiency of most operations is increased when they are performed independently of one another. Where two operations must be performed interdependently, their crew sizes should be adjusted so as to give the best balance possible, and thus reduce wait time to a minimum. Savings can usually be achieved by using the transporting equipment to perform other operations also.

HANDLING BALES OF COTTON IN PUBLIC WAREHOUSES

Methods and Equipment

By JO BRICE WILMETH, *agricultural economist*, and CHARLES D. BOLT, *industrial engineer*, *Transportation and Facilities Branch, Marketing Research Division, Agricultural Marketing Service*

PURPOSE, NATURE, AND SCOPE OF THE RESEARCH

Until the close of World War II, most materials handling in cotton warehouses was done by hand labor. Hand truckers and other hand labor were required in every operation, from unloading, weighing, sampling, transporting, and storing to breaking bales out of stacks and shipping. When mechanical tiering aids, such as portable elevators and escalators, became available, many plants used them. Likewise, many warehouses used tractor-trailer trains for transporting. But much hand labor was still required.

The labor-saving possibilities of the industrial lift truck in handling materials were demonstrated during World War II. Many leaders among cotton warehousemen became interested in finding ways to adapt lift trucks to the handling of cotton bales. This interest soon led to the development and improvement of lift-truck attachments especially designed for handling cotton bales. One of the most significant of these has been the hydraulic bale clamp. The bale clamp, which is controlled by the truck operator, generally eliminates the need for any outside manual assistance in handling a load of bales.

At the end of World War II, however, many warehousemen were still unfamiliar with lift trucks and their attachments and with other materials-handling equipment. Therefore, the cotton warehouse industry sought information and guidance on the best use of such equipment for handling bales and doing related jobs.

At the request of the National Cotton Compress and Cotton Warehouse Association, the United States Department of Agriculture initiated research in cotton handling, which resulted in this and earlier reports. The experiences and experimentation of individual warehousemen, studies by the Association's own research staff, and increased attention given by equipment manufacturers to the unique problems of cotton handling are other sources of guidance and assistance to the industry.

The purpose of the Department's cotton-handling research was to determine what handling methods and equipment cotton warehousemen can use to increase efficiency and reduce costs. Unloading, weighing, stacking, and other tasks in the warehousing of cotton were studied to determine the relative efficiency and economy of different methods. For example, a widely used manual method of breaking out bales from stocks was compared, in terms of cost, with a less known but more efficient machine method.

Interim reports have been published from time to time and made available to members of the industry. This is the seventh report on this research (the six earlier reports are listed in Literature cited, p. 74).

This report was prepared primarily for the use of cotton warehousemen. Principal findings are reported in terms of the relative efficiency and costs of different ways of doing the major handling operations. We have assumed that most cotton warehousemen are interested mainly in the conclusions of the research and not in the detailed analysis on which the conclusions were based. Therefore, this report contains only a limited amount of technical detail. Photographs, drawings, and charts have been included for further clarity.

A "Statistical Supplement" has been prepared, however, which provides, in considerable detail, the basic time and cost data used in making the comparisons in this report.

Engineers and other technicians may be interested in the detailed supporting data in the supplement, but most readers probably would not. The supplement, therefore, is not being given general distribution. However, a copy will be supplied to anyone upon request, as long as the supply lasts.

How the Research Was Conducted

The first step in planning the research in cotton handling was to decide on a classification of the handling tasks in a warehouse, so that meaningful comparisons of different handling methods could be made. It was decided that this could best be done by the separate analysis of eight basic handling operations, classified as follows:

1. Unloading (of railroad cars and road trucks).
2. Loading (of railroad cars and road trucks).
3. Weighing.

4. Sampling.
5. Transporting.
6. Storing (physically placing bales in a storage pile or block).
7. Breaking out (physically removing bales from a storage pile or block).
8. Compressing.

Compressing is a processing operation rather than a materials-handling operation. The actual compressing, therefore, was not included in this study. There are special types of handling involved in moving bales to and from the press, however, and these activities are discussed.

The next step was to select the types of materials-handling equipment to be studied for each type of operation. At the beginning of the project, there were many varied types of equipment in use throughout the industry. Hand trucks and powered lift trucks were the main types in general use when this report was written. The report includes only those types which are believed to be significant or important in handling cotton. Various kinds of materials-handling equipment used in cotton warehouses are described in the following section.

In addition to variations in types of equipment used, other important factors affect handling operations. Among these are variations in labor efficiency, methods followed, types of bales handled (flat or compressed), types of inbound and outbound transportation equipment (rail cars or road trucks of different sizes and types), and types, sizes, and functions of warehouses.

Cotton warehouses were often "handpicked" for study of certain handling methods. Early in the study, selections were based mainly on information available on facility characteristics and handling equipment used in many warehouses. The first information was obtained through the cooperation of Federal warehouse examiners and officials of the National Cotton Compress and Cotton Warehouse Association. Information accumulated during the research helped in further selections. Other warehouses were included as visits could be scheduled. Observations of handling methods and practices were made in about 360 warehouses, and time studies of selected operations were made in about 300 warehouses.

Bases and Methods for Comparisons of Efficiency and Costs

Different methods of doing the same general type of physical handling operations are evaluated in this report by comparing their estimated man-hour requirements and their dollar costs. Differences in man-hour requirements are indications of differences in efficiency. Greatest efficiency usually results when labor is used in combination with powered equipment. But equipment costs are substantial, and unless the particular equipment saves more than it costs to own and use it, there is no economic advantage in using it. Therefore, some comparisons are more meaningful in terms of dollar costs than in terms of man-hour requirements.

More efficient handling methods are generally used to save money; however, in some situations (usually temporary), it may be more important to a cotton warehouseman to save time. Therefore, the elapsed time required to complete a given type of operation is also shown for each method discussed.

In comparing different methods of doing a certain job, the effects of other variable factors (such as the number and type of bales handled and the distance bales are moved), were kept essentially unchanged from one method to another in this study. Therefore, differences in labor requirements and in costs reflected only those differences resulting from variations in method. Likewise, in the study of effects of a change in any single factor, the remaining factors were held constant.

The man-hour requirements for the handling methods described were determined through conventional time-study procedures. (*5*, pp. 73–76).[1]

The hourly wage rates for direct labor that were applied to the computed man-hour requirements are not actual average rates for the industry or any part of it. They are assumed rates, used for clarity in presentation and convenience in computating comparisons. Likewise, use of the rates in this report carries no implication that such rates are "fair" or "just." Rates used are reasonably close to those known to have been paid during the 1955–56 season in many areas of the Cotton Belt.[2]

The use of assumed rates has the further advantage that it avoids any implication that the total dollar cost computed for an operation is "exact." Dollars-and-cents figures are used throughout this report to represent the total labor and equipment costs for various operations, but it should be understood that the figures given often indicate a greater apparent degree of precision than has been achieved in fact.

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[1] Italic numbers in parentheses refer to Literature Cited, p. 74.

[2] In many areas, hourly wage rates differ from the rates herein assumed. Perhaps the most extreme differences are found in California, where rates may be 50 to 75 percent higher than the rates used in this report. The reader can substitute wage rates that apply to his own locality or situation.

In arriving at the hourly wage rates for cost purposes, no allowances were made for such additional but indirect labor costs as (1) pay for vacations and holidays; (2) employer's contributions for old-age and unemployment compensation; and (3) other fringe benefits. In some cases these extra costs may contribute greatly to the total labor bill for handling.

The equipment costs of materials-handling equipment were based on an analysis of the costs of ownership and operation reported by cooperating warehousemen over periods of 2 to 6 years. Operating costs assumed for various sizes of industrial lift trucks, for example, were based largely on actual recorded expenses. These records were kept by a number of warehousemen who cooperated in the study.

Hourly equipment costs given in this report include both ownership and operating costs. Ownership costs consist mainly of (1) depreciation allowances, (2) interest, and (3) taxes and insurance. Operating costs are those for such items as (1) gasoline, (2) oil, (3) maintenance, and (4) repairs. Not included are allowances for (1) extra facilities or building alterations required, (2) wear and tear on the warehouse building resulting from the use of the equipment, (3) office or plant overhead, and (4) general management and supervisory expenses.

Cost evaluations used herein to compare handling methods were derived by combining direct labor costs with equipment costs (for an explanation or hourly equipment costs and wage rates, see tabulation below). In this way, the labor and equipment costs were determined for each method for each operation considered.

Such cost information provides a basis for determining the relative economy of different types of equipment and different handling methods. This information is intended to assist warehousemen in deciding what equipment to buy and what methods to use.

The following tabulation shows the assumed equipment and labor costs per hour:

Hourly equipment costs [3]

2-wheel hand truck	$0.01
2-bale-capacity clamp truck	1.20
Breakout device on lift truck	1.15
Lift truck with beam scale	1.10
3-bale-capacity clamp truck	1.35
3-bale-capacity clamp truck with rotating clamps	1.45
Boom truck	1.40
4-bale-capacity clamp truck	1.80
6-bale-capacity clamp truck	2.25
Industrial tractor	.45
Industrial trailers (cost of 4 trailers)	.30
Beam scale (stationary)	.05
Beam scale (mobile, manually propelled)	.07
Beam scale (mobile, pneumatic hoist)	.10
Platform dial scale (installed)	.20
Platform dial scale (portable)	.40
Automatic dinky press feeder (installed)	.90
Portable yard ramp (magnesium)	.30

Hourly wage rates (assumed)

Unskilled labor (hand truckers, samplers, hookmen, stackers, etc.)	1.00
Skilled labor: Clamp truck and tractor operators	1.25
Recording clerks	1.50
Weigher	2.00
Example: Loading 100 bales into a railroad car with a 2-bale clamp truck would involve:	
Labor cost per hour, clamp truck operator	1.25
Equipment cost per hour, 2-bale clamp truck	1.20
Total labor and equipment hourly cost	$2.45

Time to load 100 bales into railroad car (0.75 hour) × total hourly labor and equipment cost ($2.45) = $1.84, total cost to load 100 bales into a car.

[3] Clamp trucks, lift trucks, and tractors are gasoline-propelled.

EQUIPMENT USED IN COTTON WAREHOUSES

Equipment used to handle cotton in public warehouses varies widely in type. The simplest type is the 2-wheel hand truck, used almost universally. A few facilities are equipped with elaborate and expensive monorail systems, and one warehouse observed has a large overhead crane.

Since the introduction of the powered industrial lift truck into cotton handling, use of many of the older and less efficient types of equipment has rapidly declined. Equipment such as portable elevators and escalators is rarely used now except in some small plants. The use of hand trucks also has greatly declined. In some warehouses, the hand truck is used only to transport bales from the dinky press to the main press, and all other bale handling is done by powered lift trucks. Most warehouses, however, still use hand trucks for some transporting; many smaller warehouses still use them for all transporting. Thus, hand trucks have an importance which, despite their shortcomings, cannot be overlooked.

Principal Types of Equipment Currently in Use

Equipment used to move bales into, within, and out of a public warehouse, and to perform related functions, falls into two general classes: (1) Materials-handling equipment, used primarily to move bales; and (2) supplemental equipment, used to weigh and sample bales and to aid labor and equipment in moving them and in performing other storage and handling func-

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tions. This report deals largely with equipment described in this section. Certain special uses of other types of equipment also are described.

Materials-Handling Equipment

Hand truck.—The "cotton" hand truck is used mainly to transport single bales of cotton (fig. 1); it differs in construction from most other types of hand trucks. It has two prongs at the base of the truck body instead of the conventional chisel nose. These nose prongs are used to: (1) Facilitate loading and unloading of rail cars; (2) secure the bale in transit; and (3) pry bales out of tight places when breaking bales out of storage stacks.

Boom truck.—The boom truck is a powered industrial high-lift truck equipped with a free-swinging boom attachment (fig. 2). Hooks, used to grasp and hold a bale, are suspended from the boom. The principal functions of the boom truck are to stack bales in and break them out of cordwood stacks. Other uses include the loading and unloading of road trucks and tractor-trailer trains. Sometimes the boom truck is used for breaking flat bales out of on-head stacks. A boom truck requires an operator and 1 or 2 hookmen. Also, a hand trucker may be used to move bales to and from the boom truck. One hookman may be eliminated by using a small platform attached to the face plate of the truck's mast. One worker, standing on this platform and riding up and down with the load, can hook and unhook bales (fig. 3) at both the bottom and top of the stack.

Clamp truck.—The clamp truck is a powered high-lift industrial truck equipped with clamps or "grabs" for handling the load. It is perhaps the most useful type of bale-handling equipment. Clamp trucks are used mainly to stack

BN-5059

FIGURE 1.—Worker using cotton hand truck to load compressed bale onto road truck.

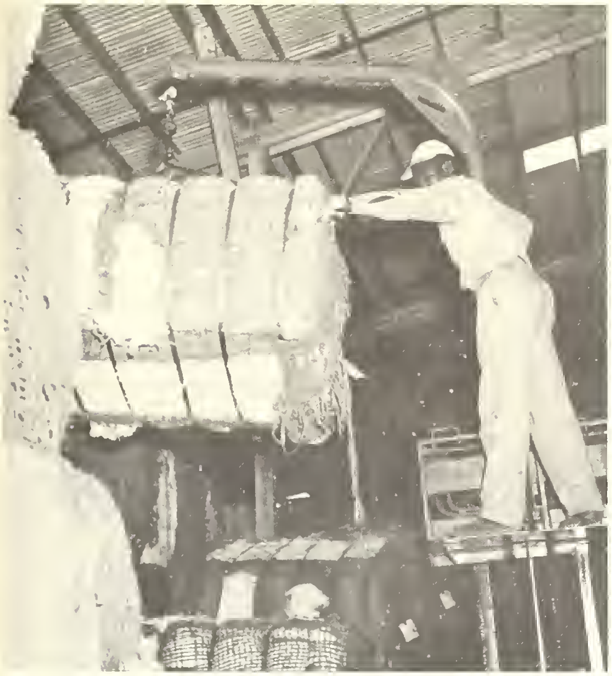
BN-5061

FIGURE 2.—Boom truck storing flat bales in an on-head stack; one hookman and hand truckers are not shown.

and transport bales, and to load and unload rail cars and road trucks. In many warehouses in which tractor-trailer trains are used, clamp trucks load and unload the trailers. Clamp trucks sometimes are used for "feeding" the dinky press.

Some sizes of clamp trucks are more suitable for certain uses than others at cotton warehouses (fig. 4). For example, 2- and 3-bale clamp trucks (fig. 5) are the only sizes in common use which are small enough to maneuver easily in boxcars. Therefore, mechanical loading and unloading of cars is done almost exclusively by trucks of these sizes. In some warehouses, loading and unloading of cars are the only jobs in which trucks of these sizes are used; other jobs are done by larger trucks. For example, larger clamp trucks may be used to load and unload road trucks and to stack and transport bales. For these jobs, 4-bale clamp trucks (fig. 6) are especially effective. Clamp trucks capable of carrying up to 6 flat (fig. 7) or 9 compressed bales are used almost entirely for transporting.

Tractor-trailer train.—A tractor-trailer train consists of 2 or more industrial trailers, pulled 1 behind the other by a tractor (fig. 8). Such a train is not confined to any fixed path but can follow the most direct routes available. Trailer trains for carrying cotton usually consist of 3 to 5 trailers. A warehouse trailer ordinarily carries 3 or 4 bales. Yard and sea-



BN-5057

FIGURE 3.—Hookman guiding flat bale into place in cordwood stack while standing on elevating platform attached to boom-truck mast.

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FIGURE 4.—Two-bale clamp truck unloading flat bales from a railroad car.

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FIGURE 5.—Three-bale clamp truck storing bales in top tier of on-head stack, three bales high.

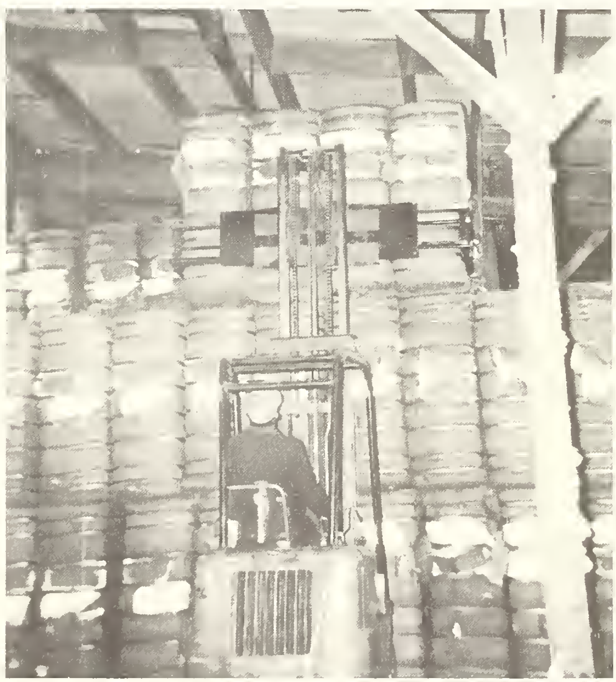

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FIGURE 6.—Four-bale clamp truck storing bales in top tier of on-head stack, three bales high.

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FIGURE 7.—Six-bale clamp truck transporting flat bales.

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FIGURE 8.—Tractor-trailer train transporting baled cotton.

port trailers, which are heavier in construction, may carry a 2-tiered load of 10 or 12 bales. Thus, the full load of a warehouse trailer train often is from 12 to 20 bales; loads going to shipside from a port warehouse may contain as many as 50 bales.

Trailer trains are at their greatest advantage in hauls over 1500 feet. In a number of plants, however, use of trailer trains has been curtailed greatly or discontinued. Long hauls in these plants are now being made by 4- to 9-bale clamp trucks. When properly used, trailer trains are an efficient, fast, and economical means of moving cotton. When improperly used, as they often are, they may be relatively inefficient and costly.

Special attachments for industrial lift trucks.—The cotton boom and cotton clamp, previously noted, are special lift-truck attachments for handling bales. Fork attachments also have been used for handling bales, but bale clamps are much better. Most cotton warehousemen who have used fork trucks have shifted to clamp trucks.

Another lift-truck attachment commonly used is a special device (fig. 9) known as a breakout attachment. This device consists of an upper arm terminating in a hook for picking up and carrying the bale, and two lower arms

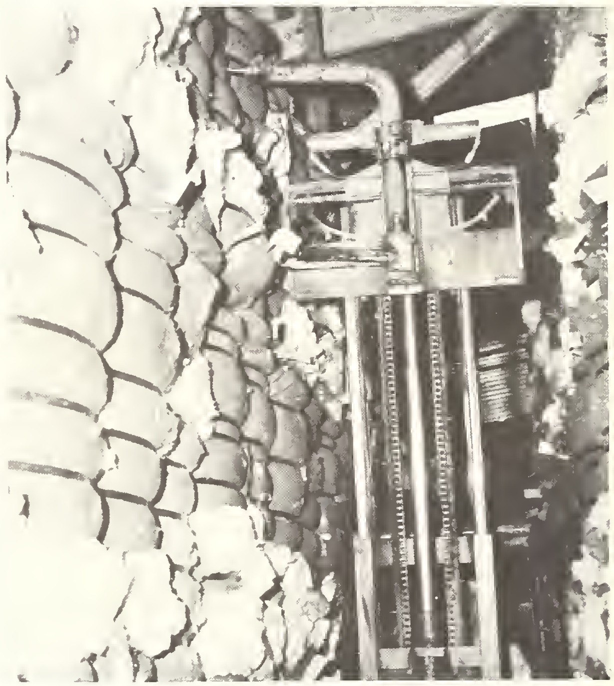

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FIGURE 9.—Breakout attachment being used to remove flat bale from top tier of stack 3 bales high.

for stabilizing the bale while in transit. The attachment can be swung to the right or left to break out bales from either side of a cross or lateral aisle. Although there are other operations in which this attachment may be used, its principal use is in breaking out bales stored on head (*4*, pp. 13–23).

Supplemental Equipment

Conventional stationary cotton beam scale.—This scale consists of a 4-legged stand or rack of A-frame design, usually made of wood, and a steelyard or weigh beam (fig. 10). Special hooks for holding the bale are attached to the steelyard.

Bales ordinarily are moved with hand trucks to and from a fixed-position beam scale. The number of hand truckers required depends on the weighing rate desired and the distance bales must be moved to the scale.

Almost every cotton warehouse has at least one conventional stationary scale, although in some it is used only in emergencies. However, this was perhaps the most widely used scale in the industry before it was replaced in many warehouses by the portable platform dial scale. In many small warehouses, it is still the only type of scale used.

Mobile beam scale.—A mobile beam scale is merely a conventional beam scale mounted on wheels for easy mobility (fig. 11). In a more elaborate form, it may consist of a beam scale mounted on a tractor or lift truck (fig. 12). A beam scale is made mobile both for easier moving and to make possible an entirely different weighing procedure. Instead of hand trucking each bale to and from the scale, the workers line up the bales in a row in advance of weighing. The bales are usually prepositioned with a clamp truck as they are unloaded from a car or truck. The scale is then passed over the bales, each bale being weighed in turn. Thus, hand truckers are not needed, and the weighing crew generally may be substantially smaller. Bales are usually tagged sometime in advance of weighing.

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FIGURE 11. Hand-propelled mobile beam scale with conventional wooden frame, being used inside warehouse to weigh flat bales in a row block. Crew consists of 1 weigher, 1 recorder, 2 hookmen (who also move scale), and 1 rope man.

BN 5055

FIGURE 10.—Conventional stationary beam scale being used to weigh flat bales. Crew consists of 1 weigher, 1 recorder, 2 hookmen, 1 rope man, and hand truckers.

BN 5051

FIGURE 12.—Power-propelled mobile beam scale (mounted on boom truck), used to weigh flat bales in row block.

The hand-propelled mobile beam scale with a metal frame is more rugged than one with a wooden frame and generally is more satisfactory. Where conditions permit, the addition of an air hoist for lifting the bale eliminates the need for a rope man in the scale crew (fig. 13). This advantage is obtained also when the scale is attached to the boom of a boom truck; however, this change greatly increases the total cost of the weighing equipment.

Mobile beam scales, both hand- and motor-powered, are being used successfully at several warehouses that annually receive large volumes of flat bales of cotton. Flat bales lend themselves most easily to weighing with mobile scales, and these scales need not be restricted to large warehouses.

Platform dial scale.—In contrast to the beam scales just described, a dial scale indicates the weight of a bale automatically; the weigher need not manipulate a poise or other scale element. As a bale is placed on the scale platform, a hand pointer or other marker quickly indicates the bale weight on the dial face. Two general types of dial scales are in use in cotton warehouses:

(1) Stationary floor scale.—The dial-type floor scale is permanently installed in a fixed location, with the platform surface at floor level (fig. 14). The usual procedure in weighing is to hand truck a bale onto the scale platform and, with the bale on the truck, to weigh both together. All hand trucks used with a given scale must weigh the same. The scale is adjusted to show a zero weight when an empty truck is on the scale platform. The scale then shows only the weight of the bale when the hand truck is loaded. Hand-truck weights usually are kept equal by the attachment or removal of small weights. The tare of each truck must be checked at regular intervals, and corrections made as required. In some cases, bales are placed upon and removed from the scale platform with clamp trucks.

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FIGURE 14.—Stationary floor platform dial scale being used to weigh bale while bale is on a hand truck. Crew consists of 1 weigher-recorder, 1 tag dropper and caller, and hand truckers.

BN-5049

FIGURE 13.—Hand-propelled mobile beam scale with special metal frame and air hoist, being used to weigh flat bales in row block. Crew consists of 1 weigher, 2 hookmen, and 1 recorder.

(2) Portable platform scale.—The portable platform scale of the types commonly used to weigh cotton consists of (1) a scale frame equipped with 4 retractable wheels; (2) a low platform, generally under 6 inches in height; (3) hinged ramps leading to the platform; and (4) a swivel dial head (fig. 15). The ramps are folded back onto the platform and the wheels protracted when the scale is to be moved. Methods for protracting and retracting the wheels and for leveling the scale at new locations vary among different manufacturers.

Bales are weighed on a portable platform scale in the same manner as on a floor scale. Most models of portable scales can easily be moved by one worker. The number of hand truckers required varies according to the weighing rate desired and the distance bales

BN-5053

FIGURE 15.—Portable platform scale being used to weigh flat bale. In this picture, the scale crew consists of only 1 man; more often, a 2-man crew is used.

must be moved. Fewer hand truckers should be required with the portable platform scale, since the shortest possible transporting distance usually can be maintained. Portable platform scales have become popular among cotton warehousemen since about 1950, and are now used in many warehouses.

Bridgeplate.—The bridgeplate, or dockboard, is a removable metal plate or ramp to span the gap between a road truck or a boxcar doorway and the warehouse platform. Although merely a handling aid, the bridgeplate is almost indispensable for most loading and unloading operations at platform level. Hand trucks, industrial power trucks, or other such handing equipment ordinarily can enter and leave the car or truck only over a bridgeplate. Proper selection of bridgeplates, with respect to design, size, strength, and weight, has an important bearing on handling efficiency.

Miscellaneous equipment.—There are several small pieces of equipment necessary to certain types of handling operations. Among these are cotton hand hooks, sampling knives, jib cranes (at compresses), band cutters, buckle breakers, and "spider killers" (tools for adjusting loose ends of bands on bales compressed to high density for export).

Other Equipment

Some other types of equipment, although in limited use, are worth mentioning because they appear to offer current or future opportunities for reducing costs. Among these types are the portable yard ramp, automatic conveyor for feeding the dinky press, mobile electronic scale, and hydraulic bale tongs or hooks. Uses of such equipment will be discussed later in connection with the operations in which each would be employed.

Other equipment, used only in special situations, includes straddle trucks, car pullers, powered sampling knives, chain hoists, elevators, escalators, gravity chutes, dragline conveyors, single-bale trailers, overhead monorail trolley systems, hand rockers, air kickers, front-end loaders, hay loaders, and mobile cranes. A warehouseman may use a certain type of equipment because he handles other products in addition to cotton. For example, some cotton warehousemen also handle peanuts, feed, or farm machinery. A front-end loader may be used to handle peanuts and feed, and also to tier cotton. Also, a mobile crane may be used to load and unload both farm machinery and bales.

Much of the equipment discussed in the preceding paragraph will not be treated further because of its limited application in current cotton-handling practices. Some of it, however, will require brief attention in connection with certain operations to be described later.

TRANSPORTING OPERATIONS[4]

Types of Transporting Performed

Transporting is one of the eight major types of bale-handling operations performed in cotton warehouses and compresses. It is concerned simply with moving bales from one place to another. To some degree, transporting is a part of all or most of the remaining seven operations, many of which are simply special types of transporting jobs. For example, loading, unloading, storing (or stacking), and certain kinds of breaking out are almost entirely transporting operations.

Other operations, such as compressing, weighing, and sampling, may contain some transportation elements. In compressing, bales must be delivered to and carried from the press

[4] All time, man-hour, and cost comparisons shown in this section are on the basis of a 100-bale unit, unless otherwise indicated.

concurrently with the pressing activities. Also, bales are moved within the operation itself, from the dinky press to the main press. Transporting also is an integral part of weighing and sampling operations, because hand trucks or other equipment carry bales to and from the scale or the sampling stations.

One important form of transporting activity, however, is most easily understood if treated as a separate and "pure" transporting operation. This form involves moving bales from one place to another between other operations, rather than as a part of other operations. For example, bales arriving at a warehouse for storage are unloaded, weighed, and sampled, and then they ordinarily are moved from the receiving area to the storage area. This movement may involve picking up the bales from a temporary block on the unloading platform and transporting them to and setting them down in a temporary block near the storing or stacking point. Similarly, bales broken out for shipment may be moved from the storage area to the loading area. Or bales may be moved from receiving or storage areas to the press area, and from the press area to storage or loading areas. Particular movements of this kind often make it worthwhile to use special transporting equipment. It usually is advisable to separate the transporting operation completely from any operations which may precede or follow it.

This section is devoted to transporting operations of the latter type. The transporting included in other types of operations will be covered later in this report.

Equipment Used for Transporting

As previously indicated, the most important type of cotton-handling equipment in use in warehouses is the powered clamp truck. Trucks of 2- or 3-bale capacity are most commonly used, although 4- or 6-bale trucks are used in some of the larger warehouses with longer transporting distances and more bales to be moved. In this section, only the transporting functions of clamp trucks are considered. However, it should be emphasized that most clamp trucks are of value to warehousemen mainly because of the other jobs they can do. The 2-bale clamp truck, in fact, is best known as a loader, unloader, and stacker, rather than as a transporter. But as the size of the load increases, the importance and economy of clamp trucks for transporting also increase. For example, the 6-bale truck has been used chiefly for transporting, although it is capable of doing other handling operations.

Not all transporting is done by clamp truck, of course. Tractor-trailer trains are used at many warehouses in which facility limitations make the use of large-capacity clamp trucks impractical. Also, 2-wheel hand trucks, though declining in importance as a means of transporting bales, are still used to some extent in almost all cotton warehouses. In fact, they are the only transporting equipment used in many of the smaller warehouses. Devices less commonly used in transporting bales are fork trucks, straddle trucks, single-bale trailers, conveyors, installed and portable elevators and escalators, hoists, chutes, and ramps.

Comparison of Time and Labor Requirements and of Costs for Alternative Methods of Transporting

In evaluating the relative efficiency and cost of the more common transporting methods, it was assumed that the necessary facilities, equipment, and manpower were available. In practice, of course, any method adopted by individual warehousemen must operate within the restrictions imposed by local conditions and circumstances.

Caution in Choice of Equipment

It should be emphasized that transporting costs alone often are not enough to indicate what transporting equipment or method is best to use. Sometimes the operation that either precedes or follows the transporting operation is a more important consideration. Some transporting equipment—such as tractor-trailer trains—is good only for transporting bales from place to place. On the other hand, clamp trucks can do many jobs; they can load and unload rail cars and road trucks, stack bales, and so on. Whenever a job best done by clamp truck immediately precedes or follows a transporting operation, one should consider the use of the clamp truck for transporting, too, so that the jobs can be done in a continuing sequence by the same machine. As an example, suppose that flat bales from a road-truck receiving yard are to be stacked in a storage compartment. If 4-bale clamp trucks are available, it might be faster and cheaper to use these trucks both to transport and to stack. The point is that the cost of all such operations taken together—not just transporting alone—should be considered.

Transporting by Hand Truck

Transporting bales by hand truck generally is slower, less efficient, and more costly than other prevailing methods. Yet most warehousemen—even those using powered equipment—feel that some transporting by hand truck often is necessary.

In transporting a bale, the trucker must load the bale onto the hand truck, push or pull the loaded hand truck to the unloading point, and unload the bale onto the floor. He then returns with the empty hand truck to the originating point to repeat the cycle. The hand trucker alone may load the bale on his truck, or he may be assisted by a "pulldown" man; he also may unload the bale at the end of the haul, or a "setup" man may help him position the bale into a block. In the transporting operations discussed in this section, it was assumed that all hand truckers pick up and release their loads without assistance from other workers. The use of pulldown men and setup men in a simple transporting operation by hand truck is seldom advisable. Such use usually results in an increase in both man-hour requirements and dollar costs with only a slight decrease in elapsed time (*5*, pp. 60-61).

Figure 16 compares (1) the number of bales transported per hour, (2) the elapsed time in hours per 100 bales, and (3) the cost for transporting (picking up, moving, and setting down) 100 flat bales of cotton with 1 hand truck and a 2-bale and a 3-bale clamp truck.[5] The time curves indicate the number of minutes required for 1 hand truck or 1 clamp truck, making the necessary round trips, to move 100 bales for varying distances. In later discussions, it was assumed that if added units were used, they would not interfere with one another. This assumption was necessary to a clear understanding of the principles involved in transporting operations. Ordinarily, then, 2 units would be expected to do a transporting job in half the time required by 1 unit, 3 units in one-third the time, 4 units in one-fourth the time, and so on; but this is not actually the case.

This relationship between the number of units and the time required is fundamental to an understanding of transporting costs. It is important to note that as additional transporting units are used, the time requirements are not reduced in equal proportions. How this fact affects certain transporting operations will be discussed later.

The costs of transporting by hand truck (discussed in greater detail in another section) are based on (1) an assumed wage rate of $1 per hour for each hand trucker, and (2) an equipment cost of $0.01 per hour for each hand truck (p. 3). The cost of transporting, for any given distance, was determined by these hourly rates and the time requirements. Time requirements are proportionately reduced as the number of hand truckers is increased. Therefore, the cost of hand trucking bales any given distance remains the same whether one or several hand truckers are used.[6]

The time requirements—and consequently the dollar costs—for transporting by hand truck increase as bales are carried longer distances. This is indicated by the graphs for hand trucks in figure 16. In some instances, this relationship between time and distance may be explained by physical factors, such as increased fatigue as transporting distances increase. In other instances, it perhaps is explained more by psychological factors, such as the trucker's inclination to avoid increased fatigue. In either case, the result is the same—the trucker's pace is slowed.

Transporting by 2-Bale Clamp Truck

The bales per hour, time requirements, and costs for transporting bales with a 2-bale clamp truck are shown in figure 16. These costs were based on an assumed wage rate of $1.25 per hour for the truck operator and an equipment cost of $1.20 per hour for the clamp truck (p. 3), totaling $2.45 per hour. It was assumed that a gasoline-powered lift truck of 2,000 pounds rated capacity, equipped with 2-bale clamps, was used.

Transporting by 3-Bale Clamp Truck

Equipment costs for a 3-bale machine of 3,000 pounds rated capacity were figured at $1.35 per hour (p. 3). Carrying an additional bale reduced the time requirements and the total costs for transporting by amounts indicated in figure 16.

Evaluation of Hand Truck and 2-Bale and 3-Bale Clamp Trucks as Transporting Equipment

Clamp trucks are relatively cheap and efficient for transporting cotton. It is evident from figure 13 that transporting bales by 2- and 3-bale clamp trucks is considerably more efficient and less costly than by hand truck. The advantage of the clamp truck is apparent even for extremely short distances, and it increases rapidly as the distance increases. These clamp trucks not only carry loads 2 and 3 times as large as the hand truck, but transport them

[5] Each of the curves for single units of equipment shown in figure 13, and elsewhere in this chapter, has been fitted to a band of scattered points representing the times actually recorded during observations of transporting operations. Such operations were for varying distances, in many different warehouses, and involved many different types of floor surfaces. Curves for multiple units of equipment can be derived from the curves for single units. These curves indicated average time requirements. The time requirements for particular warehouses and individual situations may vary above or below those indicated by a particular curve.

[6] An exception occurs when several tractor-trailer trains are served by the same loading and unloading crews. Some change in costs results as trains are added or taken out of the operation.

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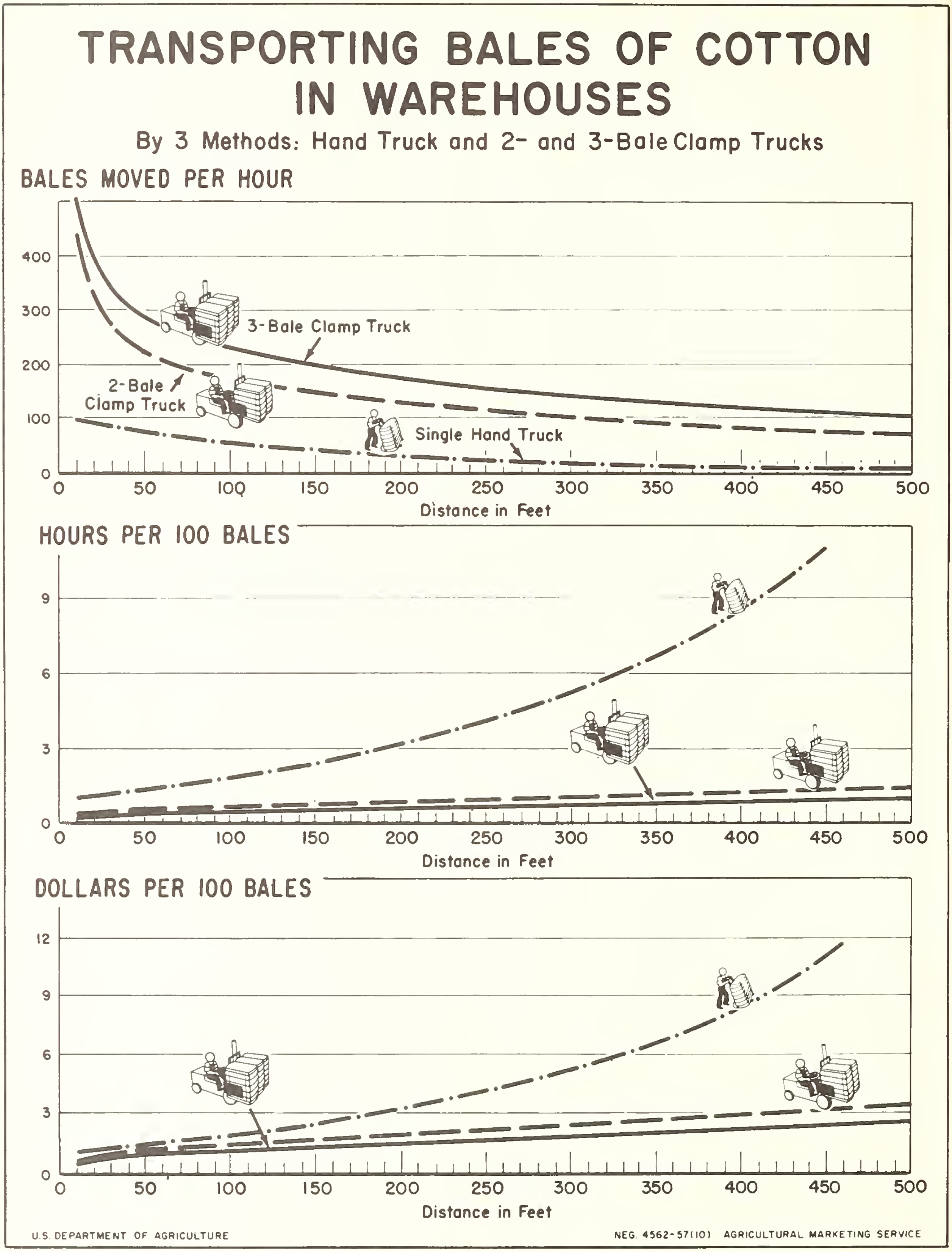
TRANSPORTING BALES OF COTTON IN WAREHOUSES
By 3 Methods: Hand Truck and 2- and 3-Bale Clamp Trucks
BALES MOVED PER HOUR
400
300
200
100
0
3-Bale Clamp Truck
2-Bale Clamp Truck
Single Hand Truck
0 50 100 150 200 250 300 350 400 450 500
Distance in Feet
HOURS PER 100 BALES
9
6
3
0
0 50 100 150 200 250 300 350 400 450 500
Distance in Feet
DOLLARS PER 100 BALES
12
9
6
3
0
0 50 100 150 200 250 300 350 400 450 500
Distance in Feet
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FIGURE 16.

much faster, particularly over longer distances. Their greater productivity is more than enough to pay for the greater hourly costs involved. Therefore, the substitution of clamp trucks for hand trucks usually results in net savings in transporting costs.

Reasons why hand trucks are still used for transporting.—From the foregoing discussion, one might conclude that no warehouseman who owns clamp trucks would ever consider using hand trucks for transporting. It is well known, however, that most warehousemen do employ hand trucks to some extent.[7]

Various reasons have been given by warehousemen for doing this. Some of the reasons given seem open to criticism. Among these are the following:

1. "Lift trucks are meant for lifting—not transporting." Therefore, it is claimed, clamp lift trucks should be used only in tiering operations such as loading or stacking, and their use for transporting, even in these operations, should be held to a minimum.

Comment: Regardless of the original purpose of the lift truck, there are many situations in the cotton warehouse industry where it is considerably cheaper to transport bales with a 2- or a 3-bale clamp truck than by hand truck.

2. "Bales can be moved more quickly by hand truck than by clamp truck."

Comment: Obviously, for any given distance and any particular number of clamp trucks, there is some number of hand truckers that can move bales at a faster rate. But hand trucking of bales, whether one or more hand truckers are used, can be done only at a higher cost (fig. 16). When speed is more important than cost, the warehouseman generally will find it cheaper to assign additional clamp trucks to transporting jobs, rather than to assign the number of hand truckers needed to achieve the same transporting rate.

3. "To use mechanical equipment when labor is readily available for doing a particular job is to incur unnecessary wear and tear on the equipment."

4. "If labor is on hand, it should be kept busy. This is desirable even if equipment, which might do the job more efficiently, remains idle."

Comment: The last two statements represent "borderline" reasons; sometimes they may be valid, at other times they may not. Many warehousemen frequently find that, for some parts of a day, more workers are on hand than are actually needed for the work to be done. In such situations, it often is impractical to release surplus workers to save direct labor expense. The workers may have been hired for a specific period for which they will draw pay, or they may be needed later in the day for other jobs. Under such circumstances, a warehouseman may be justified, on the basis of savings in gasoline, oil, and other direct equipment operating expenses, in using hand labor. But if surplus labor is available almost every day, the warehouseman should carefully consider hiring fewer day-to-day workers. Possibly more efficient organization, better scheduling of operations, and more effective use of labor-saving equipment could maintain the desired production rate with fewer workers.

There also are several valid reasons for using hand trucks rather than clamp trucks. Among these reasons are:

1. "Clamp trucks are not available, or may be used more productively on other operations, at the time the transporting is to be done."

Comment: There are, of course, times when a warehouseman must use equipment or methods which are less efficient than those he might ordinarily use. For example, the only lift truck in a small warehouse may be laid up for repairs. Sometimes the only machine available is located, when needed, at some remote place in the warehouse. If only a few bales are to be moved, it often is cheaper to hand truck them than to spend time going for the lift truck. In still other cases, all lift trucks may be engaged in operations where they are more productive than transporting. Then it usually is cheaper to transport by hand truck than to withdraw a lift truck for this purpose. If there is no hurry about the transporting job, it may be better, of course, to defer it until a lift truck becomes available.

2. "Congested aisles or platforms do not permit clamp trucks to be used effectively."

Comment: Congestion of aisles or platforms generally is a temporary condition which the warehouseman tries to avoid as much as possible. But while congestion is present, hand trucks sometimes are the only transporting equipment that can be used.

3. "Weak floors, narrow platforms, or other facility shortcomings may make the use of clamp trucks impractical in certain areas of the warehouse."

Comment: Most cotton warehouses were built when handling was done primarily by manual labor. Many warehouses, therefore, have certain features that are undesirable in mechanical handling. Such shortcomings may be relatively permanent or temporary, depending on the cost of making needed changes. For example, the costs generally are moderate for strengthening floors and platforms so that they

[7] It should be emphasized that in this section only those transporting operations divorced from other operations are discussed. Hand trucks often are employed in other operations in which some transporting is involved (for example, weighing). Such operations will be discussed in the sections dealing directly with those operations.

will support 2- or 3-bale clamp trucks. These costs usually are much less than the additional long-time cost of using hand trucks instead of clamp trucks. But some types of building alterations may be so expensive that the warehouseman may hesitate to undertake them. Much depends on his type and scale of operations. Until such time as lift trucks can be used in all sections of the warehouse, some hand trucking of bales is almost inescapable.

4. "Transporting is geared to the production rate of another operation so that it is cheaper to transport by hand truck than by any other means."

Comment: Such situations often occur, as illustrated by the following example. Suppose that, immediately after compressing, bales are to be moved from the buck bar near the press to a temporary block 50 feet away on the shipping platform. There they are to be checked for later loading into cars. Suppose also that the press maintains an average rate of 100 bales per hour. If the transporting rate were not restricted by the pressing rate, 2 hand truckers could move 100 bales the 50 feet in about 40 minutes, at a cost of approximately $1.40. On the other hand, a 2-bale clamp truck could move them in about 27 minutes, at a cost of about $1.10 (fig. 16). But in this example the transporting rate, whether by hand or clamp truck, is restricted by the lower pressing rate. The number of bales that can be moved in an hour is limited to the number of bales pressed (100 per hour). Transporting, then, in either case also requires 1 hour. The total labor and equipment cost of moving 100 bales, at 100 bales an hour, would be $2.02 if 2 hand trucks were used and $2.45 if a clamp truck were used (p. 3). Obviously, in this and similar situations, it would pay a warehouseman to use 2 hand trucks in preference to a clamp truck.

Transporting by 4-Bale Clamp Truck

If enough transporting is done, it may pay a warehouseman to use equipment capable of carrying 4, 6, or more bales on each trip. Some warehousemen, operating plants of moderate to large size, have found 4-bale clamp trucks well suited to their transporting needs. An important advantage of the 4-bale clamp truck is that it can be used also to load and unload road trucks and to stack bales.

The 4-bale clamp truck usually has a rated capacity of 4,000 pounds or more. It has clamps large enough to grasp 4 bales at a time. Bales per hour, time requirements, and costs of moving bales various distances with a single 4-bale clamp truck are indicated in figure 17. These costs are based on an assumed wage rate of $1.25 per hour for the truck operator, and an assumed equipment cost rate of $1.80 per hour for the clamp truck (p. 3).

Transporting by 6-Bale Clamp Truck

In several large warehouses, transporting costs have been reduced still further by employing 6-bale clamp trucks with a rated capacity of 6,000 pounds or more. Trucks of this type have been used in some plants to carry 9 or more compressed bales. Their widest use, however, is for 6-bale loads.

Figure 17 indicates the speed at which bales may be moved with a single 6-bale transporter, and the costs of transporting with this type of equipment. These costs are based on an assumed wage rate of $1.25 per hour for the truck operator, and an assumed equipment cost of $2.25 per hour for the clamp truck (p. 3).

Transporting by Tractor-Trailer Train

For some long-haul transporting, tractor-trailer trains may have advantages over clamp trucks. From some port warehouses, for example, bales may be carried several blocks to shipside; from other warehouses, they may be hauled several miles over public streets. In this report, however, operations extending much beyond the warehouse premises are not discussed in detail.

The trailer-train operations discussed are those that are applicable to transporting within or around the warehouse itself. For simplicity, it is assumed that a train consists of 4 trailers, each carrying 4 flat bales, so that 16 bales are delivered on each trip. The principles of operation are the same for flat or compressed bales. The only differences occur in the loading and unloading procedures. These differences in procedure may be, and often are, reflected in slight differences in cost.

Advantages of transporting by tractor-trailer train.—In general, tractor-trailer trains have the following advantages:

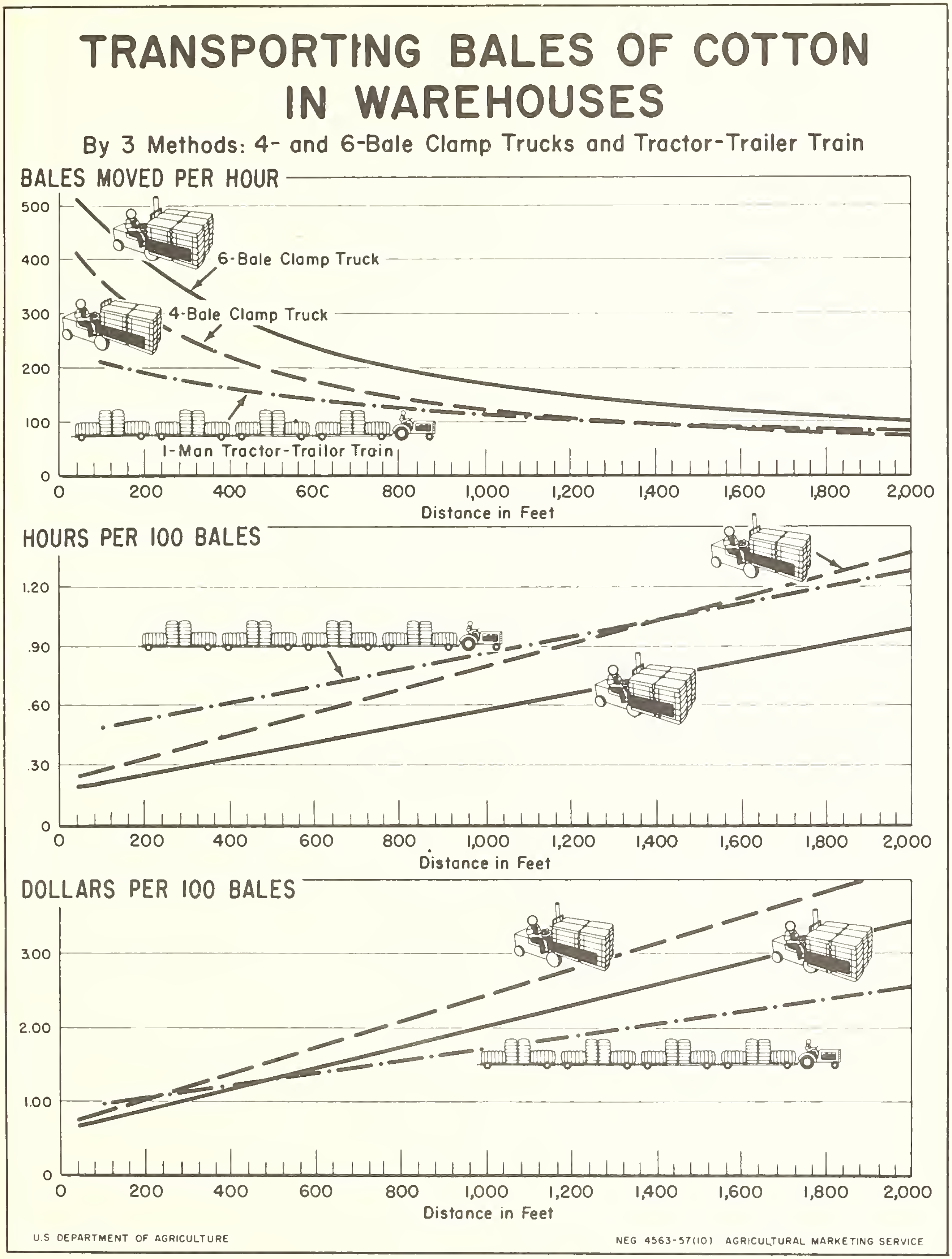
1. Trailer trains often can be used in warehouses where the floor or other structural members do not permit the use of the heavier 4- or 6-bale clamp trucks.

2. Trailer trains may often be used for transporting operations in open yards and over surfaces unsuitable for many clamp trucks.

3. The initial investment for a tractor and four trailers is considerably less than that for any other types of equipment capable of moving bales at the same rate. This factor may make tractor-trailer trains more attractive to some warehousemen.

Disadvantages of transporting by tractor-trailer train.—Some disadvantages of trailer trains are:

1. Trailer trains may easily become one of the most expensive means of transporting



TRANSPORTING BALES OF COTTON IN WAREHOUSES
By 3 Methods: 4- and 6-Bale Clamp Trucks and Tractor-Trailer Train
BALES MOVED PER HOUR
500
400
300
200
100
0
6-Bale Clamp Truck
4-Bale Clamp Truck
1-Man Tractor-Trailor Train
0 200 400 60C 800 1,000 1,200 1,400 1,600 1,800 2,000
Distance in Feet
HOURS PER 100 BALES
1.20
.90
.60
.30
0
0 200 400 600 800 1,000 1,200 1,400 1,600 1,800 2,000
Distance in Feet
DOLLARS PER 100 BALES
3.00
2.00
1.00
0
0 200 400 600 800 1,000 1,200 1,400 1,600 1,800 2,000
Distance in Feet
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Figure 17.

where the best methods of operation are not used.

2. Larger crews are often required, thus aggravating problems of supervision and control.

3. More space is required for the operation of trailer trains and for storage of the equipment when not in use than is required for some other equipment.

4. Where several trains and separate equipment or crews for loading and unloading are involved, considerably more time is required to assemble equipment and personnel for any given operation.

5. The number of trains and tractors required for greatest efficiency may vary from one operation to another. This is likely to be true where separate loading and unloading crews are used. (Since clamp trucks are self-loading and self-unloading, this problem does not arise in connection with their use.)

6. Tractor-trailer trains can be used only for transporting, whereas clamp trucks can be used also for loading and unloading rail cars and road trucks and for stacking bales.

Factors affecting the cost of tractor-trailer train operations.—Costs are affected by the amounts of labor and equipment required for the movement of bales, and the elapsed time required to complete the movement. In operations in which 3 or 4 tractors and operators were used, it was not uncommon also to use 3 to 8 workers to load and another 3 to 8 workers to unload the trains. Thus, from 2 to 4 times as much labor was used to load and unload trains as was used in operating them.[8] The cost of trailer-train operations in which loading and unloading crews of 5 and 6 workers were used was discussed in an earlier report (*6*, pp. 26-34). In that report, the cost of transporting bales 1,000 feet varied from $6.00 to $13.00 per 100 bales, depending on the organization of the operation. In this report, 2 of the better trailer-train methods are described, with the factors contributing to their efficiency.

The 1-man tractor-trailer train operation.—The most efficient and least costly tractor-trailer train operation observed was the 1-man operation. In addition to driving the train, the tractor operator loaded and unloaded the train without assistance. For the 1-man operation, bales were pre-positioned so that 4 bales were directly opposite each trailer when the train was halted for loading.

When the tractor operator both loads and unloads, the efficiency of trailer-train operations is increased in at least three ways: First, separate loading and unloading crews are eliminated. Second, the operator's time is spent productively at both ends of the haul. Third, such a 1-man operation is self-balancing.

The time required for loading and unloading naturally varies with different operations, operators, and trips by the same operator. But in this report it will be assumed that the time for any specified elements of a handling operation remains the same for each cycle and for each method. The times used for transporting 16 bales per train, based on time studies, were as follows: Loading a train, 2.96 minutes (about 0.05 hour); unloading, 1.28 minutes (about 0.02 hour); and travel times for 1 round trip of a single train for varying travel distances:

Travel feet	*Travel time (round trip) minutes*
200	1.28
400	2.08
600	2.88
800	3.68
1,000	4.48
1,200	5.28

The total time requirements and total labor and equipment costs for a 1-man trailer-train transporting operation are shown in figure 17. Time requirements are proportionately reduced by each train added to the operation until loading, the "bottleneck" operation, begins to delay the trains.

Tractor-trailer train operations with loading and unloading by clamp truck.—Compressed bales can be handled by this method almost as easily as flat bales. However, this method ties up at least 2 clamp trucks and 2 operators, 1 of each at both the loading and unloading stations.

The loading and unloading procedures are fairly simple. In loading flat bales, for example, the clamp truck simply picks up 2 bales at a time from a temporary block near the train, and sets them on head on the trailers. In this study, when bales were moved about 20 feet, loading and unloading each required 2.70 minutes. If bales were unloaded into a stack or carried more than 20 feet, more time would be required. Compressed bales are placed on the trailers in an on-side position. The time for loading is 2.88 minutes, and for unloading, 3.26 minutes.

Time requirements are proportionately reduced by each train added until the bottleneck element begins to delay the train movements. The bottleneck occurs when enough trains are used so that trains have to wait. Since additional trains cannot increase the rate of flow nor reduce time requirements, they can only add to the costs.

Costs can be reduced by adding trains until the number of trains reaches the capacity of the clamp truck to load them without train delays. It is equally apparent, however, that such reductions become progressively smaller per 100 bales with each train added. To show their

[8] As an extreme example, in operations observed at 1 warehouse, 22 hand workers were used in the unloading crew.

relationship more clearly, suppose that bales are to be hauled 2,000 feet. The costs for such a movement, when the trains are loaded and unloaded by clamp truck, are as follows:

Number of trains	Cost per 100 bales	Reduction in cost
1	$9.98	
2	6.43	$3.55
3	5.25	1.18
4	4.66	.59
5	4.31	.35

(If 6 trains were used the cost would increase from $4.31 to $4.75.)

From these cost relationships, based on the particular loading, unloading, and travel times used, the following conclusions seem reasonable where separate loading and unloading crews with clamp trucks are used:

(1) Where transporting distances are between 300 and 1,000 feet, 3 trains probably are better than 4. With 3 trains, costs average about the same as with 4, but fewer workers and less equipment are needed.

(2) Use of 4 trains rather than 3 is desirable if most hauls are between 1,000 and 1,600 feet.

(3) Use of 5 trains is unnecessarily expensive for most distances under 1,600 feet.

Those conclusions are based on trailer-train loading and unloading operations where bales are assumed to move about 20 feet to and from the trailers. On this assumption, an estimated 2.70 minutes were required to load a train, and the same time to unload it. Table 1 shows how different loading times affect the number of trains that is most economical. The range of times shown is believed to be fairly typical of that found among warehouses using tractor-trailer trains.

This table may be useful as a rough guide in determining a specific number of trains that might be most efficiently used in all operations of the warehouse. This number could be changed from day to day; it probably is better, however, not to change the number any more than is necessary during any single day.

TABLE 1.—*Number of tractor-trailer trains needed for economical transportation of bales at various distances and loading times, using clamp trucks to load and unload.*

Distance bales are transported	Travel time (round trip)[1]	Number of trains by various loading times per train[2]				
		1.5 minutes	2.0 minutes	2.5 minutes	3.0 minutes	3.5 minutes
Feet	*Minutes*	*Number*	*Number*	*Number*	*Number*	*Number*
200	1.28	3	3	3	2	2
400	2.08	3	3	3	3	2
600	2.88	4	4	3	3	3
800	3.68	4	4	3	3	3
1,000	4.48	5	4	4	3	3
1,200	5.28	5	5	4	4	3
1,400	6.08	6	5	4	4	4
1,600	6.88	6	5	5	4	4

[1] Travel time plus twice the loading time (loading time and unloading time assumed to be equal) equal the total cycle time.

[2] Estimates of number of trains for most efficient operation over a specified distance obtained by dividing the total cycle time for that distance by the loading time. These estimates were checked by cost calculations based on use of 1 man and a clamp truck at each end of haul to load and unload.

Cost Comparisons of Clamp Trucks and Tractor-Trailer Trains in Transporting Bales a Fixed Distance

Line graphs shown earlier in this section indicated relative costs, among various powered equipment, for picking up, transporting, and setting down bales, for different distances. In the following paragraphs, relative costs for transporting bales and placing them in a block by various methods and equipment over a fixed distance of 1,000 feet are compared. At this distance, hand trucks would seldom be used; hence, comparisons were made only among different sizes of clamp trucks and tractor-trailer train systems.

Data developed from field studies show that among tractor-trailer systems the highest cost, $7.10, was for a single complete train (tractor and 4 trailers) loaded and unloaded by clamp truck. The unduly high cost was due to the amount of idle time of clamp trucks and operators when only 1 train was used. The cost was reduced when idle time was reduced by using additional trains. With 2 complete trains, the cost was $4.62; with 3 trains, $5.37; with 4 trains, $4.98. Four trains gave a somewhat faster movement—0.28 hour per bales instead of 0.34 hour for 3 trains. The cost was increased when 3 and 4 trains are used because additional clamp trucks are needed for loading and unloading.

The cost for the 1-man tractor-trailer train operation, plus the cost of moving bales 50 feet to a temporary block with a 2-bale clamp truck, was $4.05 for 1 or 2 trains. But the rate of movement was doubled with 2 trains, rising from 110 to 220 bales per hour. When 3 trains were used, some wait time occurred, although the elapsed time was reduced from 0.45 to 0.31 hour. The rate of movement was increased only to 324 bales per hour, because it was held down by wait time.

Among the clamp trucks, the highest cost, $6.00, was for the 2-bale truck,[9] while the lowest cost, $2.03, was for the 6-bale truck. The cost of transporting by 3-bale clamp truck was $4.37, and by 4-bale clamp truck, $2.44.

[9] The reader should not forget that the cost of transporting by two-bale clamp truck is far less for most distances than by hand truck.

Both the 4-bale and 6-bale trucks, operating singly, moved bales faster at 1,000 feet than the smaller capacity clamp trucks; they also moved them faster than single tractor-trailer trains. Elapsed time per 100 bales for 1,000 feet ranged from 2.45 hours for the 2-bale truck to 0.58 hour for the 6-bale truck.

The 3-bale and 2-bale trucks often are of the same model, but one uses wider clamps than the other. The 4-bale machine, however, is a heavier and faster truck. Its increased speed contributes greatly to the lowering of transporting costs. The 4-bale truck also may be used efficiently in loading and unloading road trucks, in stacking, and in other operations; this makes it a desirable transporter in many moderate-sized warehouses. The 6-bale truck is preferred in many of the larger plants, especially for relatively long hauls, because of its greater economy and speed.

Other Equipment Used for Transporting

Equipment other than that discussed so far is used for horizontal transporting in some warehouses. Among this equipment are fork trucks, straddle trucks (5, p. 54), single-bale trailers, and various types of conveyors. Most of this equipment is used for special purposes.

Also, warehouses with more than one floor usually have special equipment for vertical transport. Such equipment includes permanently installed elevators and portable elevators, hoists, ramps, and chutes. The equipment varies considerably, not only as to type but as to the manner in which it can be used. More so than other types, equipment for vertical transport is related to the particular facility in which it is used. For this reason, no more than a few general comments about it are offered.

Among vertical lifting and lowering devices, elevators and hoists may become serious bottlenecks. Escalators and chutes usually are better, but may require more labor for loading and unloading. Ramps, if wide enough and with the correct grade for easy negotiation by clamp trucks, are perhaps the best means of carrying bales from one floor to the next. But such ramps, unless installed outside the warehouse, take up room that often is needed for storage or other purposes.

Where hoists, elevators, escalators, or chutes are used, transporting activities on the floors below and above should be well balanced to prevent accumulation of wait time on one floor or the other. Attendants at elevators and escalators should be held to the minimum consistent with the needs of a particular movement. All floor-to-floor operations, where they cannot be avoided, should be carefully supervised and controlled. Even under the most favorable conditions, they are great wasters of time and labor.

Road Trucks as Warehouse Transporters

Warehousemen should not overlook the fact that, under some circumstances, road trucks can be used to good advantage for "warehouse" transporting. Such an advantage is gained, for example, when loaded incoming road trucks "spot" the bales as near as possible to the storage compartment. This saves the warehouseman much time and expense in moving bales from a more distant unloading point. But many warehousemen, by failing to provide suitable unloading facilities for trucks, are unable to take advantage of this type of saving.

Another possibility: Road trucks may bring newly arrived bales directly into a warehouse compartment for unloading at the storage point. Fire insurance regulations do not permit road trucks, under their own power, inside a cotton warehouse unless approved mufflers are used. However, with suitable warehouse floors and other structural features, road trucks can be towed into and out of a warehouse with an industrial tractor or lift truck. In many instances, this would permit moving an entire truckload of 40 or 50 bales to the storage area at one time. These bales would not be unloaded, weighed, and sampled in an outside loading court.

UNLOADING OPERATIONS[10]

Unloading From Railroad Cars

As indicated in the preceding sections, most cotton-handling operations include transporting of bales as an important part of the operation. In comparing methods of unloading in this chapter, a uniform distance of 50 feet was assumed for transporting bales directly from a rail car or road truck to a temporary block. In the following discussion of unloading from rail cars, it was always assumed that a car carries either 50 flat bales or 100 compressed bales. This transporting was included in the overall time and cost for unloading.

Most larger warehouses are equipped with rail facilities for direct unloading of cotton

[10] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

onto warehouse platforms from cars. On the other hand, many of the smaller warehouses have no rail facilities and receive and ship mostly by truck; rail shipments, if any, can be handled only on team tracks (tracks some distance from the warehouse).

A few plants with rail facilities, including 1 or 2 larger compresses, are not equipped with platforms at car-floor level, and must unload cotton "at ground level." In some instances where cotton is unloaded at ground level, bales are simply pushed out the car door onto the ground or pavement; in other instances, they are carried from the car to the ground over a movable ramp.

Unloading Onto Car-Floor-Level Platforms

When rail platforms are at car-floor level, bales may be unloaded from box cars by equipment moving in and out of the cars over a dockboard or bridgeplate. For this purpose, two main types of equipment have been used, (1) hand trucks and (2) clamp trucks.

Prior to about 1950, cars were unloaded by hand truck in most warehouses. By 1955, however, in practically all of the larger plants and in many small plants with rail facilities, cars were being unloaded only by clamp truck. Those plants that still use manual- and hand-truck methods for unloading usually do so for one or both of the following reasons: (1) The overall warehouse facilities, or at least the unloading facilities, may not be physically adequate for the use of clamp trucks; (2) the number of bales normally handled may be—or at least is believed to be—too small to justify the outlay for a clamp truck.

Unloading by manual and hand-truck methods.—In unloading cars by hand truck, the usual practice has been to use 2 or 3 "breakout" men in the car to help the hand truckers. These men pull, or otherwise break out, individual bales from their positions in the car, and assist in loading them onto hand trucks. Generally, from 4 to 10 hand truckers are used in transporting bales from the car to the temporary block. As a rule, however, bales are routed through a weighing operation and then a sampling operation before being placed in the block. This block may be 75 to 100 feet from the car, to allow room for the weighing and sampling stations. If bales are transported longer distances, even more truckers may be used. In most such operations observed, more hand truckers were used than were really necessary. So the truckers spent much of their time waiting in line, and thus contributed to inefficiency and unnecessarily high costs.

Unloading cars by hand truck directly into a temporary block was not a common operation when this research was done. Consequently, the time and manpower requirements for such operations were ascertained by analysis of common unloading operations which included the same 2 basic elements: (1) Breaking out bales by hand, and (2) hand trucking bales from the car to a block. Practically all hand-truck unloading operations contain these 2 elements. But in addition, they usually include also weighing and sampling operations between the car and the block. It was necessary, therefore, by means of time-study analysis, to eliminate the effect of weighing and sampling operations upon the unloading operation itself. This provided the basis for the following discussion of car-to-block unloadings.

The duties of individual crew members in unloading a car by hand are essentially the same for both flat and compressed bales. Also, where bales have been properly loaded, about the same time is required. On the other hand, where compressed bales have been loaded improperly, causing "log jamming," the breakout time may be considerably lengthened. This means extra time for opening car doors and for placing and removing bridgeplates and other equipment. Time for these jobs, varying with the number of cars handled and the methods used, was not included in the unloading times here discussed.

Time-study analysis showed that only 2 breakout men and 2 hand truckers were needed for unloading a car by hand truck directly into a temporary block at 50 feet. In fact, there was evidence that the breakout crew might economically be reduced to 1 man. Breakout men for unloading often would not be needed at all if bales were not tiered when loaded into box cars. The breakout men work entirely in the car; the hand truckers work both in the car and between the car and the temporary block. Truckers assist in breaking out, whenever necessary, by prying out bales with the nose prongs on their trucks, and in other ways.

A 4-man unloading crew, with duties distributed as indicated above, requires about 0.84 hour of elapsed time, or 3.36 man-hours of labor, per 100 flat bales. This crew unloads about 119 bales per hour. Unloading is thus done at a total labor and equipment cost of $3.38 (fig. 18). Unloading compressed bales takes about the same time, and therefore costs approximately the same amount.

The "bottleneck" element that determines the elapsed unloading time in this particular operation is the breakout time in the car. Breakout time requires 0.84 hour when 2 breakout men are used. Two hand truckers are the smallest number that can move bales from the car to the block as fast as they are broken out. If only 1 hand trucker were used, the breakout men would have frequent waits before the hand

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trucker returned, and unloading would take longer. If more than 2 truckers were used, the truckers frequently would wait on each other and unloading time would remain the same as for 2 truckers. So, with no reduction in unloading time but with a larger crew, the cost would increase. There is no reason, therefore, further to consider this latter method.

Suppose, however, that instead of a third hand trucker, a third breakout man were used. Unloading time would then be reduced from 0.84 to about 0.71 hour. But this reduction in time is not enough to prevent an increase of about $0.18 per 100 bales in cost. So this change is of doubtful value. On the other hand, suppose that, instead of 2 breakout men, only 1 breakout man were used. Certain studies of unloading where 1 breakout man and 1 hand trucker worked inside the car (with 1 hand trucker outside the car) suggest that unloading time would be perhaps 10 percent longer. But, because the unloading is now done with only 3 instead of 4 workers, the cost would be lower, by about $.50 per 100 bales.

Unloading by clamp truck.—In unloading cars, clamp trucks also are used to unload bales and to move them to the block. It is thus a self-balancing operation, with no built-in wait time. Unloading with a single clamp truck usually takes less elapsed time than manual- and hand-truck methods; it also is much less expensive because it takes much less labor. For example, unloading flat bales with a 2-bale clamp truck and 1 man takes 0.79 hour per 100 bales compared with 0.84 hour for a 4-man hand crew. The net labor and equipment cost is reduced from $3.38 to $1.94, although wage rates and equipment costs are higher. The assumed hourly wage rate for a clamp-truck operator is $1.25, compared with $1.00 for workers in a hand crew. The lift truck replacing the hand truck has an assumed cost of $1.20 per hour.

No more than 2 flat bales at a time can be carried through a car door by clamp truck. However, compressed bales, which are smaller, may be unloaded 3 at a time. To unload compressed bales 2 at a time normally takes 0.81 hour and costs $1.98 per 100 bales. When they are unloaded 3 at a time, the elapsed time is reduced to 0.69 hour and the cost to $1.79. For a clamp truck to carry 3 bales in each load, a 3,000-pound-capacity truck, fitted with a special clamp having a wide spread, is generally used.

Unloading Cars at Ground Level

Relatively few plants are equipped to unload rail cars at ground level. Where possible, most warehousemen provide facilities for platform unloading. But the layout or other characteristics of some plants that load and unload cars at ground level sometimes are such that the structural changes required for car-floor-level handling would be prohibitive in cost.

The method most widely used for unloading cars at ground level is the manual push-out method. A more efficient method is to unload by clamp truck over a portable ramp.

Unloading by manual push-out method.—A typical procedure for unloading by hand (which uses a larger crew than necessary) is as follows: (1) Inside the car, 2 men break out and 1 man hand trucks bales to the car door and dumps them onto the ground; (2) on the ground, 2 men receive each bale as it falls from the car door, guide it so that it falls in an upright position, and then load it onto a hand truck; and (3) 4 hand truckers move the bales 50 feet to a temporary block.

This method, in spite of the much larger crew, is no faster than the manual method described for unloading onto a platform at car-floor level. The estimated elapsed time for unloading flat bales in this manner, by a 9-man crew, is 0.84 hour per 100 bales (fig. 18). Man-hours of labor with a crew of this size are 7.56, and total costs are $7.60. The time and cost for unloading compressed bales differ only slightly.

Time-study analysis of this typical method indicates 3 ways of improving it. First, the number of hand truckers can be reduced from 4 to 2, since 2 can keep up with the breakout rate as well as 4. Second, 1 of the 2 men working on the ground below the car door can be eliminated without slowing down the overall unloading time. Thus, with these changes alone, the crew is reduced from 9 to 6 workers and the cost from $7.59 to $5.07. The third change is elimination of 1 of the 2 breakout men in the car. This change reduces the crew size to 5 men, but, because the breakout rate is slowed, the unloading time is increased from 0.84 to 0.92 hour. The net effect, however, is to reduce the cost of unloading from $5.07 to $4.63 (fig. 18).

Unloading by clamp truck over a portable ramp.—Movable ramps greatly increase the efficiency of unloading cars at ground level by making it possible to use a clamp truck. Lightweight ramps of the magnesium-aluminum type are suitable for this purpose when there is enough room alongside the rail tracks. Most such ramps extend about 30 feet outward from the door of the car. However, ramps that can be placed parallel to the car may be obtained from some manufacturers.

The elapsed time for unloading with a 2-bale clamp truck over a portable ramp is only 6 to 8 minutes less than that for unloading by the manual push-out method, but the cost is reduced substantially. For example, the cost of

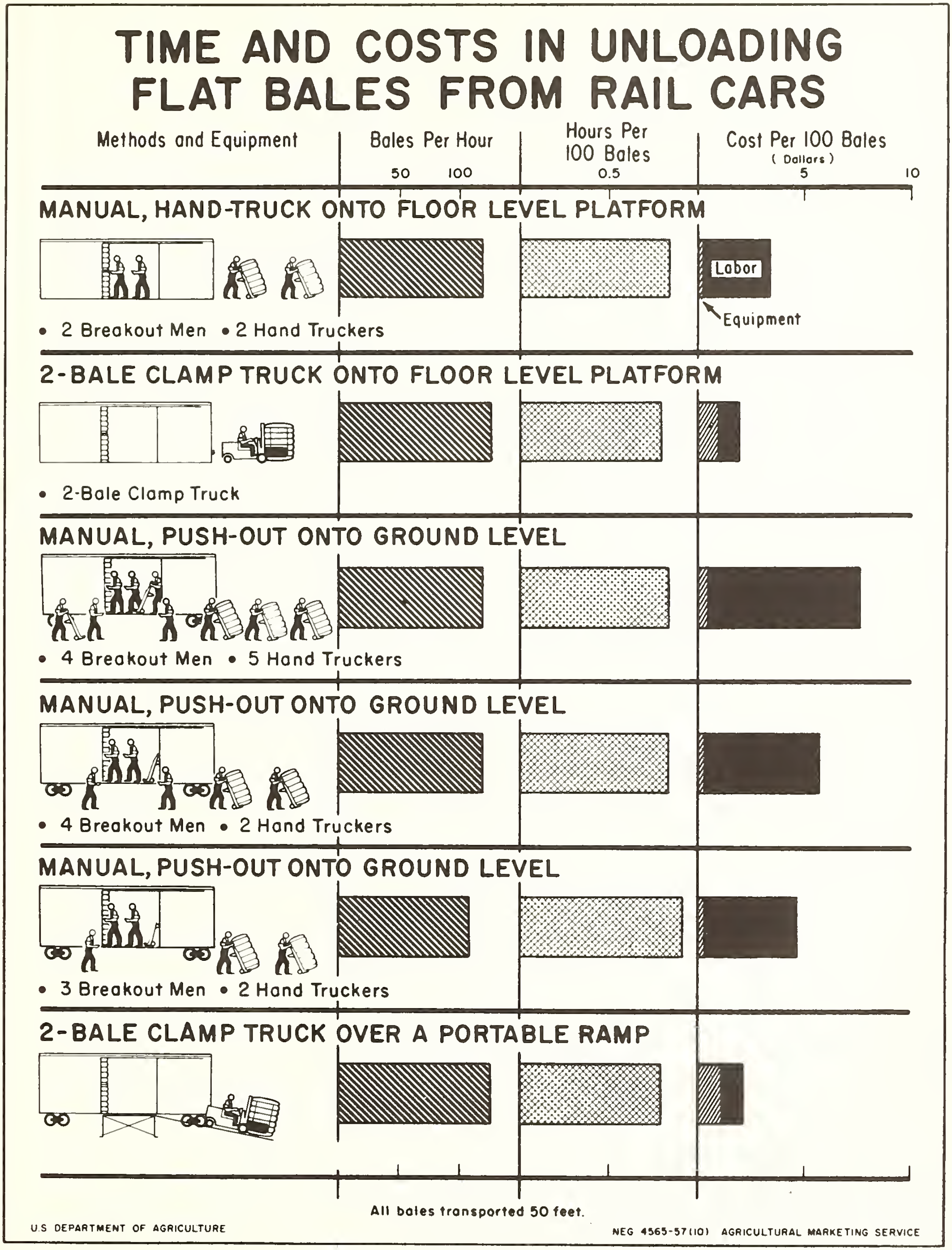
TIME AND COSTS IN UNLOADING FLAT BALES FROM RAIL CARS
Methods and Equipment
Bales Per Hour
50
100
Hours Per 100 Bales
0.5
Cost Per 100 Bales
(Dollars)
5
10
MANUAL, HAND-TRUCK ONTO FLOOR LEVEL PLATFORM
• 2 Breakout Men • 2 Hand Truckers
Labor
Equipment
2-BALE CLAMP TRUCK ONTO FLOOR LEVEL PLATFORM
• 2-Bale Clamp Truck
MANUAL, PUSH-OUT ONTO GROUND LEVEL
• 4 Breakout Men • 5 Hand Truckers
MANUAL, PUSH-OUT ONTO GROUND LEVEL
• 4 Breakout Men • 2 Hand Truckers
MANUAL, PUSH-OUT ONTO GROUND LEVEL
• 3 Breakout Men • 2 Hand Truckers
2-BALE CLAMP TRUCK OVER A PORTABLE RAMP
All bales transported 50 feet.
U.S. DEPARTMENT OF AGRICULTURE
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FIGURE 18.

unloading flat bales is reduced to $2.17 as compared with $4.63 for the 5-man operation described previously. Comparable reductions occur in unloading compressed bales. Moreover, if a 3-bale clamp truck is used to unload compressed cotton, the time is reduced from about 0.81 to 0.69 hour, and the cost from $2.23 to $2.

Overall time requirements are approximately the same for unloading by clamp truck and portable ramp onto the ground as for unloading onto a platform at car-floor level. However, in addition to unloading time, considerable extra time is required for moving the ramp from car to car, when several cars are unloaded in sequence. To move a bridgeplate or dockboard from 1 car to the next coupled car by clamp truck requires from 2 to 3 minutes; to move a portable magnesium ramp of the types currently available usually requires from 7 to 8 minutes. These elapsed times per car (and the cost incurred) are in addition to those already shown for unloading only.

Unloading From Road Trucks

Unloading road trucks and trailers differs from unloading cars in several ways. Methods are most alike in unloading by hand truck; they differ most in unloading by clamp truck or other mechanical means. In the following discussions, the term "road truck" is used to include "road trailers."

Unloading Onto Truckbed-Level Platforms

The two general methods most commonly used for unloading from road trucks onto warehouse platforms are (1) the manual and hand-truck method; and (2) the manual and clamp-truck method. Whichever method is used, 1 or more breakout men work on the road truck. In one case, the breakout men help load bales onto hand trucks for removal from the road truck; in the other, they move bales into position for pickup by a clamp truck on the platform.

Unloading by manual and hand-truck methods.—As in unloading rail cars, the breakout men pull bales out of tight positions and assist in loading them onto hand trucks. Hand truckers move their equipment onto and off the truckbed by means of a bridgeplate at the tailgate.

To unload flat bales into a block 50 feet away, only 2 hand truckers usually are needed (although more frequently are used) when 2 breakout men work aboard the truck. For this 4-man crew, 0.84 hour of elapsed time and 3.36 man-hours of labor are required. The cost of unloading, then, is $3.38 (fig. 19). These requirements are the same as for unloading a car by the same method.

Compressed bales are unloaded similarly. Elapsed hours, man-hour requirements, and cost are about the same as for flat bales.

Unloading by clamp-truck methods.—The cheapest and most efficient way to unload a road truck at platform level is to have the clamp truck go onto the truckbed to pick up bales. This eliminates any need for a breakout man on the truck. However, many owners or operators do not permit clamp trucks on the beds of their road trucks. The clamp truck must therefore work from the platform, picking up bales from the edge of the truck and carrying them to the block. On the truck, the breakout man shifts bales when necessary so the clamp truck can reach them. When the road truck is parked parallel to the platform, he does this entirely by hand. If bales are unloaded over the tailgate, however, he will likely use a hand truck in shifting the bales.

Unloading is faster if the truck is parallel to the platform. A 2-man crew, described above, requires about 0.77 hour for unloading when a 2-bale clamp truck is used. Total labor and equipment cost for the job is therefore $2.66. The time and cost for unloading by clamp truck at ground level are shown on page 23. No observations were made of operations in which 3- or 4-bale clamp trucks were used to unload at platform level. However, it seems reasonable to assume that the elapsed times would be roughly the same for both ground and platform unloading. This assumes, however, that a breakout man works aboard the truck when the clamp truck is operating on the platform. Then use of a 3-bale clamp truck for unloading can reduce the time to about 0.61 hour and the cost to $2.00. A similar computation is that, with a 4-bale clamp truck, the elapsed time can be reduced to 0.46 hour and the cost to $1.86.

Unloading at Ground Level

The man-hour requirements and cost for unloading road trucks by hand are generally higher when unloading at ground level than at platform level. On the other hand, unloading by clamp truck is generally cheaper at ground level. This is because bales can be removed by machine from both sides of the road truck. Thus, a breakout man to shift bales to the edge of the truckbed is not usually needed.

The examples that follow are for flat bales. The labor requirements and costs for unloading compressed bales, where similar methods can be used, differ little from those for flat bales.

Unloading by manual push-off methods.—The most common method of unloading by hand is to push the bales off the sides of the truck onto

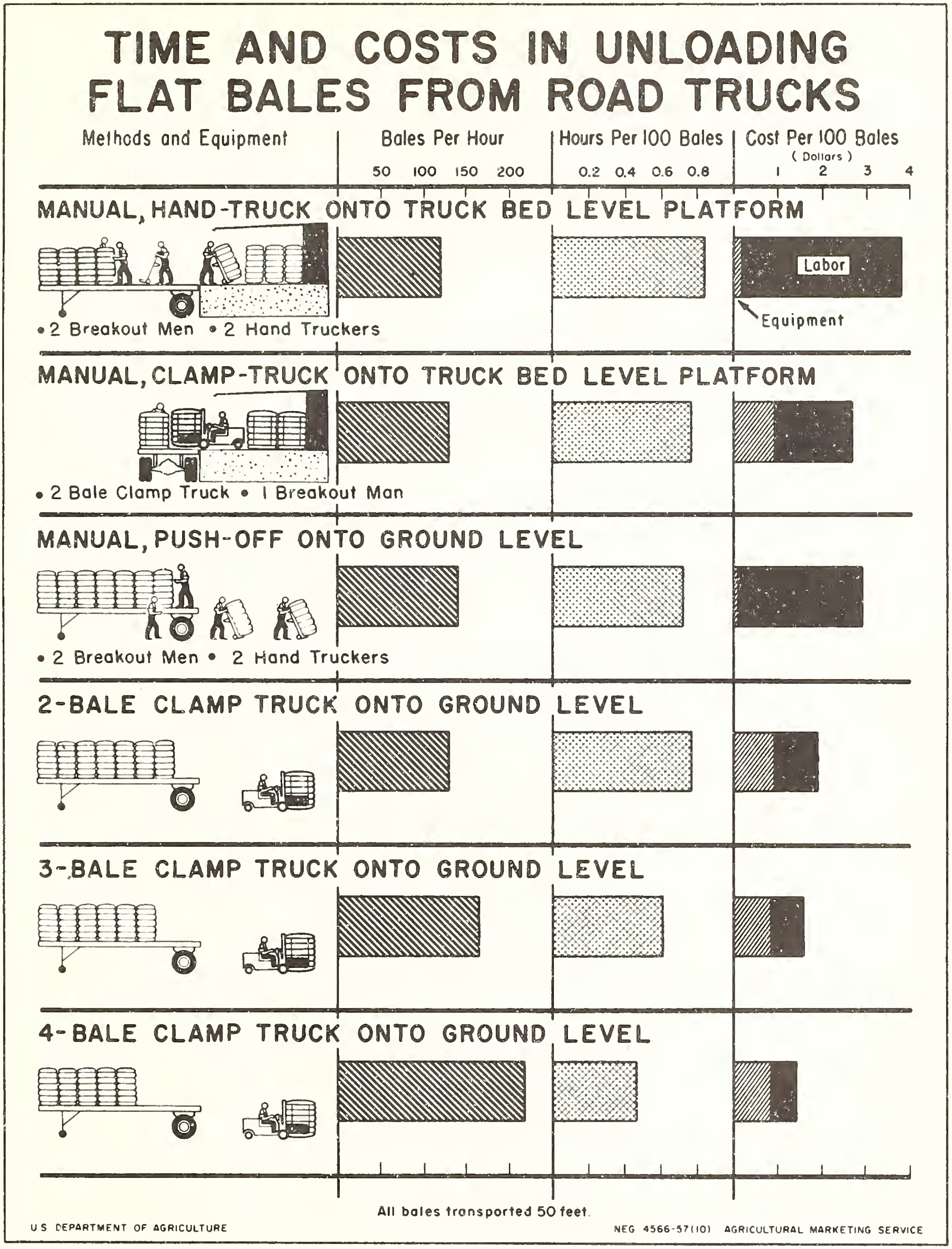
TIME AND COSTS IN UNLOADING FLAT BALES FROM ROAD TRUCKS
Methods and Equipment
Bales Per Hour
50 100 150 200
Hours Per 100 Bales
0.2 0.4 0.6 0.8
Cost Per 100 Bales
(Dollars)
1 2 3 4
MANUAL, HAND-TRUCK ONTO TRUCK BED LEVEL PLATFORM
• 2 Breakout Men • 2 Hand Truckers
Labor
Equipment
MANUAL, CLAMP-TRUCK ONTO TRUCK BED LEVEL PLATFORM
• 2 Bale Clamp Truck • 1 Breakout Man
MANUAL, PUSH-OFF ONTO GROUND LEVEL
• 2 Breakout Men • 2 Hand Truckers
2-BALE CLAMP TRUCK ONTO GROUND LEVEL
3-BALE CLAMP TRUCK ONTO GROUND LEVEL
4-BALE CLAMP TRUCK ONTO GROUND LEVEL
All bales transported 50 feet.
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FIGURE 19.

the ground. At some warehouses, bales are pushed off in an orderly manner from a slowly moving truck into neat rows for weighing, sampling, or permanent yard storage. But at most warehouses, the truck remains in place while it is unloaded, and the bales simply fall into piles on both sides of the truck. Obviously, in such cases merely pushing bales off the truck bed does not complete the unloading operation. The bales cannot be left in piles or disorderly groups, but must be cleared from the unloading area and made ready for the next operation. This usually is done by moving them into a temporary block by hand truck.

If one man breaks out bales and pushes them over the sides of a truck and a second man, on the ground, guides them into an on-head position for easy pickup by hand, about 0.72 hour of elapsed time is required. Two hand truckers are needed to move bales into the block within this time. For this 4-man crew, unloading requires 2.88 man-hours and costs $2.89 (fig. 19). The unloading time can be shortened to approximately 0.54 hour by using a second man on the truck to push off bales. Then it becomes necessary to use 3 instead of 2 hand truckers so that bales can be moved to the block as fast as they are pushed off. The cost of unloading is increased to $3.26.

Unloading by clamp truck.—Methods using clamp trucks are more efficient than the manual and hand-truck method just described. The only workers needed are the clamp-truck operators. The elapsed time and the cost for unloading both decrease as larger unit loads are handled. In each of the following examples, the elapsed time is shown for 1 clamp truck. Unloading time can be reduced by approximately half if 2 clamp trucks instead of 1 are used. Man-hour requirements and total labor and equipment costs remain the same, however.

When 1 clamp truck is used, it often is better for the unloader to alternate between the 2 sides of the road truck. This procedure maintains a more even distribution of weight on the truckbed. This is especially important with tiered truckloads. When 2 clamp trucks are used, each machine should work from a different side of the road truck. The estimated time for unloading with a 2-bale clamp truck is 0.77 hour and the cost is $1.89. If a 3-bale clamp truck is used, unloading takes about 0.61 hour and the cost is $1.59. A 4-bale clamp truck cuts elapsed time to 0.46 hour and cost to $1.40.

At a few warehouses, 6-bale clamp trucks are sometimes used for unloading. For best results, this method requires that the bales be previously loaded by a 6-bale machine in a pattern known to the unloader. Where this method can be used, additional savings in time and cost are possible.

The preceding comparisons indicate that operators of the larger warehouses, which permit a fuller and more efficient use of large clamp trucks, may be able to save money by using 4-bale or larger machines in unloading road trucks. The savings from unloading with larger clamp trucks are even greater when bales are transported considerable distances from the truck to the block. For example, in some warehouses, bales unloaded in an outside yard are transported directly from the truck to the warehouse storage compartment. Weighing and sampling here are done in the storage area rather than in the unloading area. In such cases, savings resulting from unloading in larger unit loads are increased by the savings from transporting in larger loads by the same equipment. The need for a temporary block near the truck is eliminated.

Other Methods for Unloading Road Trucks

Formerly many warehousemen used either hand-cranked or electric hoists, combined with manual handling, for unloading trucks. Some plants used boom trucks. By 1955 the number of plants using such equipment and methods had declined considerably. More and more warehouses were switching to clamp trucks for unloading. A few small plants that have no other unloading equipment continue to use hoists. Also, hoists or boom trucks are occasionally used, even in larger plants, where bales are delivered to the warehouse in road trucks with fixed sideboards.

WEIGHING OPERATIONS[11]

Generally, weighing is the first operation after unloading. Where bales are unloaded with hand trucks, most weighing is done directly in conjunction with unloading. Also, this combination of operations frequently includes sampling, transporting to the storage area, and storing.

In this section, only those weighing operations that originate from a temporary block are discussed. This block may be of a special type, where flat bales are lined up in a long row for weighing by a mobile scale; or it may be

[11] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

any block in which bales are placed as they are unloaded from a rail car or road truck.

In some types of weighing operations, each bale is brought to a stationary or fixed-position scale by hand truck or machine. In other types, a mobile scale moves along a row of bales, weighing each bale in place.

Weighing With "Fixed-Position" Scales

For purposes of this discussion, a scale has a fixed position if it remains in one location while all bales in a carload, truckload, or lot are weighed. "Fixed-position" scales, therefore, are not limited to permanently installed platform scales, but include "portable" platform dial scales and conventional stationary beam scales. Both of these letter scales may be moved from one position to another to shorten distances. But in comparing weighing methods, it is assumed that the scale remains in one location while each lot of bales is weighed.

The weighing crew for a fixed-position scale ordinarily consists of (1) a scale crew, and (2) hand truckers. The function of the scale crew is to weigh the bale when it reaches the scale and to record the weight and other related information. The function of the hand truckers is to transport bales to and from the scale. The travel time for hand truckers discussed in this chapter is based on a round-trip distance of about 150 feet traveled during each cycle.

The longest "bottleneck" element (other than transporting) in the weighing cycle usually determines the maximum rate at which bales can be handled. In most cases, the bottleneck is in the activities directly or indirectly connected with the actual weighing of a bale. For a given weighing rate, the smallest number of hand truckers or other transporters needed can be determined. In the following comparisons, this minimum number of transporters has been used. The reader should keep in mind that these comparisons of operations assume ideal weighing conditions—not necessarily the conditions that are found in practice.

When weighing is done with a fixed-position scale, flat and compressed bales are handled alike. Bales are handled differently only if sampling is integrated with weighing. The time, man-hours, and cost requirements for weighing also are about the same for both types of bales. Comparative data used to illustrate weighing with fixed-position scales have, therefore, been limited to flat bales.

Conventional Cotton Beam Scales

In carrying bales to and from a conventional beam scale, the usual practice, in each cycle, is for the hand trucker to: (1) Pick up the bale and move it directly below the steel yard; (2) wait while the bale is lifted from the hand truck and weighed; (3) wheel the bale to a temporary block or to a sampling station; and (4) return with empty hand truck to pick up another bale and repeat the cycle.

Hand truckers waiting in line in approaching the scale may tie the warehouse tag onto the bale bagging, or they may tie the bag while weighing is in process. Sometimes bales are not tagged until they are sampled. In the operations discussed here, tagging does not affect the overall time requirements for weighing.

In addition to hand truckers, from 1 to 5 scale workers are required, depending on how the various duties are distributed. Six-man scale crews have not been unusual, but time-study analysis does not show any advantage ordinarily in having more than 5 men. A scale crew of 1 to 3 workers may be adequate if bales are received in small lots and speed in weighing is not important. Where a faster rate of weighing is desired, scale crews of 4 to 5 workers may be used to advantage.

The elapsed time for handling an individual bale at the scale is largely determined by the size and organization of the scale crew. However, the total elapsed time for weighing any number of bales in succession is determined in part by the rate at which bales are brought to the scale. With any given transporting distance, this rate depends, up to a point, on how many hand truckers are used.

Weighing with a 5-man scale crew.—Figure 20 shows how elapsed time and costs for weighing with a conventional beam scale and a 5-man scale crew, are affected by the number of hand truckers used. The optimum of 4 hand truckers (determined as indicated below) is used to compare the efficiency and cost of a beam scale with other types of scales.

The 5 members of the scale crew have duties distributed as follows: (1) A hooker handles hooks on one side of the bale and calls the old tag number; (2) a second hooker handles hooks on the opposite side of the bale; (3) a ropeman handles the lever to raise and lower the bale; (4) a weigher "drops" the warehouse tag on the bale, handles steel yard, and calls out the weight; and (5) a recorder records weight and other information.

Time-study analysis shows that such a crew requires about 16 seconds to weigh a bale. Only about 0.43 hour (26 minutes) is required to weigh 100 bales, if enough hand truckers are used to prevent all waiting by the scale crew. However, it seldom is possible to eliminate wait time by this means. If enough hand truckers are used to move bales through the scale at the maximum rate possible, another type of wait

time usually develops. Whenever a hand trucker waits in line, additional time is required to start the truck moving again into place at the scale. Studies show that this "lag time" amounts to between 6 and 7 seconds, or about 0.11 minute. This lag time must be added to the weighing time to determine the time for the bottleneck or pace-weighing cycle is 0.26 plus 0.11, or 0.37 minute. If, however, fewer hand truckers are used than the minimum number required to weigh at this rate, lag time need not be taken into account. The significance of this will be considered shortly. At least 4 hand truckers are required, for the distances given in figure 20, if the maximum attainable weighing rate is to be achieved.

The number of hand truckers was determined by:

1. Adding the time for each element of the weighing cycle to find the total elapsed time for a complete cycle (round trip) by each hand trucker, excluding irregular delays. The total

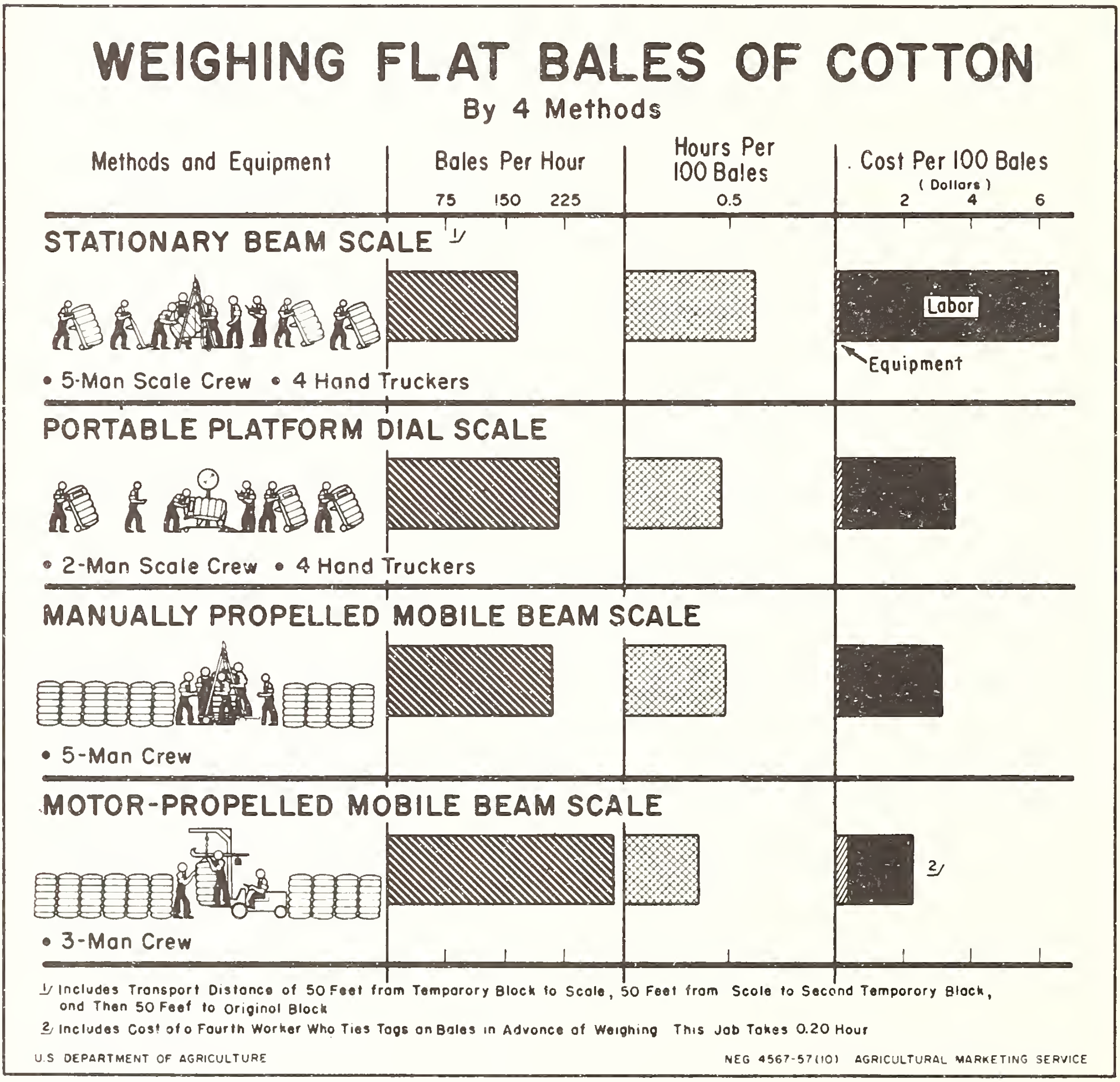

Figure 20.

trucking distance of 150 feet was divided into separate stages as follows:

Pick up bales from 1st block and move 40 feet to point immediately behind trucker at scale	0.38 min.
Re-start hand truck after stop, and move bale 10 feet to scale ("lag time")	.11 min.
Weigh bale (scale crew picks up, weighs, and returns bale to truck)	.26 min.
Move bale 50 feet to 2nd block and set bale down	.41 min.
Return with empty hand truck 50 feet to 1st block	.21 min.
Total elapsed time for 1 complete cycle	1.38 min.

2. Dividing 1.38 minutes bv 0.37 minute, the "bottleneck" time in the weighing cycle; the resulting quotient, 3.7, indicates the number of hand truckers needed. Thus, 4 truckers, the next higher whole number, are needed. This is the smallest number that can move bales to the scale fast enough to achieve the maximum weighing rate.

If more than 4 truckers are used, the handling rate will remain at its maximum. Total man-hours, wait time of hand truckers, and costs, however, will increase. If fewer than 4 are used, the handling rate will decrease but man-hours, scale crew, wait time and costs will still increase. With 4 hand truckers, or a 9-man weighing crew, elapsed time is approximately 0.62 hour and 5.58 man-hours are required, and total costs are $6.57. If 3 instead of 4 truckers are used, weighing requires about 0.72 hour of elapsed time and 5.76 man-hours of labor, and costs are $6.90.

Weighing with a 4-man scale crew.—In some instances a 4-man scale crew is used, but assignments differ little from that of the 5-man crew. One of the 2 hookers—usually the 1 who is not a tag caller—also acts as rope puller. Then weighing time is slowed from 0.26 minute to about 0.30 minute per bale. The bottleneck time in the total weighing operation then becomes 0.30 minute + 0.11 minute (lag time), or 0.41 minute.

Analysis similar to that for the 5-man scale crew shows that 4 hand truckers also are necessary to maintain the maximum rate for the 4-man scale crew. For this 8-man weighing crew, therefore, the elapsed time per 100 bales is approximately 41 minutes, or 0.68 hour. This represents 5.44 man-hours of labor and a total labor and equipment cost of $6.52. If 3 instead of 4 hand truckers are used, lag time is eliminated. Nevertheless, total elapsed time is increased to about 0.74 hour. The cost, however, is decreased to approximately $6.35. (The reader is cautioned against interpreting these small time and cost differences as "real" differences always to be found in practice. It is perhaps safer to say that the differences shown indicate tendencies. These may or may not be reflected in real differences in any particular instance or situation. More will be said later about certain factors to be considered in deciding how many hand truckers or what size scale crew to use in weighing.)

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Automatic Platform Dial Scales

Automatic platform dial scales are used in many cotton warehouses. The oldest form is the permanently installed stationary floor scale. The platform of this scale is flush with the floor. This type of scale serves well where bales can be economically concentrated near the scale. The stationary scale is at a disadvantage, however, where bales must be grouped some distance apart. The portable platform scale is a more recent type of automatic platform dial scale. The portable scale has all of the operational advantages of the installed floor scale plus the advantage of movability. Like the conventional beam scale, it may be brought to the weighing area, so that hand-trucking distance can be reduced to a minimum.

The weighing time per bale for a 2-man scale crew (1 weigher-recorder and 1 tag dropper-caller) is about 0.16 minute (or 10 seconds) for either scale. This compares with 0.26 minute, or about 16 seconds, for a stationary beam scale with a 5-man crew. When 4 hand truckers are used, lag time for truckers is no problem. This is because 4 truckers are too few, at the assumed trucking distances, to maintain the maximum rate of flow to the scale. With 4 hand truckers, 28 minutes, or 0.46 hour, are required for weighing (per 100 bales). When 5 hand truckers are used, they must wait in line before the scale; thus, lag time (0.11 minute per bale) must be added to the weighing time. So, although the additional hand trucker tends to increase the rate of flow, the lag time tends to offset the increase. The cost of weighing with automatic platform dial scales is discussed in the next two subsections.

Stationary floor scales.—A floor scale may offer an economical and efficient means of weighing if: (1) Bales, in being transported from the unloading areas to the storage areas, are funneled along the same route; (2) a floor scale can be economically installed on or near that route; and (3) there is enough room available in the scale area to block out weighing lots at short distances from the scale.

Under favorable conditions, the stationary floor scale provides a faster and cheaper means of weighing than the conventional beam scale. Weighing with a conventional beam scale should take from 0.62 to 0.74 hour and cost from $6.35 to $6.90, depending on the size and organization of the total crew. If a stationary floor scale were used, the elapsed time would be 0.45 hour

and the cost $3.56 with a 2-man scale crew and 4 hand truckers.

Sometimes bales must be moved to a stationary floor scale that is a considerable distance from direct routes to the storage area. These extra transporting costs must be added to the costs of weighing. Direct weighing costs are increased, too, if the weighing blocks are so far from the scale that more hand truckers are needed. In such situations, the portable platform scale may be more economical.

Portable platform scales.—Weighing on a portable platform scale can be as fast as on the stationary floor scale. In addition, the portable scale can be moved near the bales to be weighed, thus holding hand-trucking distances to a minimum.

The estimated hourly cost of a portable platform scale is $0.40, compared with $0.20 for the stationary floor scale (p. 3). Where the hand-trucking distances are the same for both scales, the direct weighing costs for a portable platform scale are a few cents higher. But transport distances are likely to be substantially greater with stationary floor scales than with portable scales. Where this occurs, total weighing costs with stationary floor scales are substantially higher, in spite of the lower initial cost of the scale itself.

Relation of the Number of Hand Truckers to Weighing Efficiency

For any given hand-trucking distance, elapsed time and costs vary with the number of truckers used for transporting bales to and from the scale (fig. 20). Maximum elapsed time results when only 1 trucker is used; minimum time and cost result when the optimum number for that particular distance are used. Costs increase as the number of truckers either increases or decreases from the optimum number.

In considering the use of either the conventional fixed-position beam scale or the automatic platform dial scale, it will be useful to refer to the discussion in the section on transportation. There the numbers of hand trucks, clamp trucks, other pieces of equipment needed in cotton transport operations are considered. Reductions in elapsed time resulting from adding units of transporting equipment become smaller and smaller with each such addition. Often it makes little difference whether slightly fewer or more than the optimum number are used.

The exact number to use in any given situation is necessarily a matter for management decision. Sometimes a considerable portion of the day may be spent moving a beam scale or a portable platform scale from one location to another. Also, at some warehouses, most weighing, even at one location, is done intermittently. At such warehouses, bales may arrive at irregular intervals by truck. It frequently may be more economical, therefore, to use a smaller weighing crew than that indicated by time studies to be "most efficient." Reduction of the crew size also reduces the amount of labor wasted between operations and in moving from one work station to another. Care must be taken, of course, that this saving is not offset by decreased efficiency in the weighing operation itself.

Weighing With Mobile Scales

It was pointed out earlier that a principal advantage of using the mobile scale is the elimination of all hand truckers from the weighing crew. The scale crew not only weighs each bale but also moves the scale from bale to bale. Mobile scales have been used almost entirely for flat bales. Indications are that, under certain circumstances, they may be used almost as effectively for weighing compressed bales. But at the writing of this report, data on such operations are insufficient for proper evaluation.

Flat bales should be placed into one or more rows for weighing with a mobile scale. Ordinarily, such rows should be formed by the clamp machine as it unloads a rail car or road truck. Enough space should be left between rows to permit passage of the scale unit and of weighing and sampling crews. Bales should be pre-positioned in rows for sampling as well as for weighing.

In most of the weighing operations studied, clerical and other tasks related to the weighing operation were performed along with it. These tasks include: (1) Tying on tags; (2) checking tag numbers against the weight sheet; and (3) recording, for each bale, the old and new tag numbers, number of bands, type of bagging, and gross weight. In many situations, however, it pays to do most of these jobs in advance of weighing, leaving only the recording of the bale weight to be done during the actual weighing operation. Frequently, this procedure results in a more efficient use of labor and in speeding up the weighing rate. Unless otherwise indicated, however, it is assumed in describing the following operations that these tasks are performed by the scale crew at the time of weighing.

Hand-Propelled Mobile Beam Scales

A hand-propelled mobile beam scale is simply a conventional cotton beam scale with the frame mounted on wheels or casters (fig. 11). The frame is often of a special design and of metal. With the scale frame straddling the bales, the scale is rolled down the row with the steelyard

or weighbeam passing over the bales. Usually the 2 hookmen, 1 on either side of the row, push the scale from 1 bale to the next.

The scale is stopped long enough to weigh each bale. The weight is obtained in much the same manner as with a fixed-position beam scale. The hookmen insert hooks into the sides of the bale, the bale is lifted and moved free from adjacent bales, and the weigher obtains the bale weight. Then the bale is lowered into position beside the bale previousy weighed, the hooks are removed, and the scale unit is pushed (about 2½ or 3 feet) to the next bale in the row. The entire cycle is then repeated. Tagging, recording descriptive information concerning the bale, and related tasks also are done during this cycle.

The scale crew usually consists of 5 workers organized in somewhat the same way as the 5-man crew for the fixed-position beam scale described earlier. A minor change is that usually a hookman or the rope man ties the tag onto each bale. The elapsed time for completing a weighing cycle with a 5-man scale crew is 0.29 minute (or a little over 17 seconds) per bale. At this rate the time per 100 bales is 0.48 hour (29 minutes). This represents a weighing rate of approximately 208 bales per hour. Some crews, however, have on occasion been able to weigh at a much faster rate. When weighing is done in 0.48 hour, the direct weighing cost is $3.15.

Hand-Propelled Mobile Beam Scales With Pneumatic Lifts

When the bale is lifted for weighing by air hoist instead of by hand, the rope man can usually be eliminated. The weigher then usually handles the controls for raising and lowering the bale. With an air hoist, the elapsed time for weighing, even with the smaller (4-man) crew, is reduced to about 0.41 hour (a weighing rate of almost 245 bales per hour). Thus, the net cost of weighing (excluding any allocation of costs for the compressor installation itself) is reduced from $3.15 to $2.30.[12] The labor savings obtained through this method are many times larger than the additional direct cost of using the air hoist.

However, a disadvantage is that special equipment is required to supply the compressed air. Because of the difficulties in providing compressed air, mobile scales equipped with air hoists are not widely used.

[12] One firm, which has been using this type of scale for several years, has been able at peak activity to weigh 100 bales in from 0.30 to 0.40 hour, or rates between 250 and 330 bales per hour. At 0.35 hours of elapsed time, the computed cost is $1.96.

Motor-Propelled Mobile Beam Scales

Beam scales mounted on farm tractors, industrial lift trucks, and other powered vehicles have been used at some warehouses. Such equipment provides mechanical movement of the scale as well as powered lifting of bales for weighing.

Use of motorized instead of hand-propelled mobile scales involves some reassignment of duties among the scale crew. For example, the rope man is replaced by the tractor or lift truck operator. This operator handles the controls that raise or lower the bale. As a result, it may be possible to assign additional duties to the hookmen, or to assign hooking and unhooking to other members of the crew.

Unless the crew size can be reduced by motorizing the scale, it is seldom worthwhile to motorize it. Use of a lift truck or tractor adds substantially to equipment costs. Also, under unfavorable conditions the weighing rate of a motorized beam scale may be no faster and may even be slower than that of a hand-propelled one. Therefore, total weighing costs would be increased unless the increased equipment charges were offset by reduced labor costs.

Time studies were made of operations in which a 3-man weighing crew used a beam scale suspended from an elevating boom mounted on a lift truck. The boom placed the weighbeam or steelyard directly over the row of bales alongside the truck. The weigher, who stood on a small platform attached to the front of the truck, not only performed his usual duties, but also attached and released hooks on one side of the bale (fig. 12). The recorder, who worked on the ground, handled the hooks on the other side of the bale. There also was one other important change; the tag men, instead of working with the scale crew, tied on all bale tags before weighing.

With this crew organization, 0.35 hour of elapsed time and 1.05 man-hours of labor normally are required for the weighing itself (fig. 20). To this should be added 0.20 man-hour for tying on tags in advance of the weighing operation. Total direct labor and equipment costs for tagging and weighing are $2.25 per 100 bales. If the tagger works as a fourth crew man, instead of tagging in advance of weighing, the cost is increased to $2.40.

In 1954, one warehouseman designed bale tongs or hooks to replace the hand-operated scale hooks he was using. The tongs are actuated by the hydraulic system of the lift truck. The weighbeam is suspended from the tip of a boom, and the tongs are linked to the beam in the same way as conventional scale hooks. The scale crew is reduced to 2 workers, as the 2 hookmen are not needed, since the tongs are under the control of the lift truck operator.

The weigher does the recording. A special desk and seat for the weigher are mounted on the front of the lift truck. They are so positioned that the poise is within convenient reach of the weigher. The weigher can ride from bale to bale, manipulate the poise at each bale, and read and record the weight for each bale.

Before weighing a given lot or block of bales, all bales in the lot are tagged. Also, a weight sheet is prepared, listing each bale by both old and new tag numbers and giving other essential information. These tasks may be done by 1, 2, or more men, depending on the speed desired. The 2-man scale crew follows the tagging and checking crew. The entries of the bale weights thus completes the weight sheet.

The authors did not have an opportunity to observe the operations and equipment just described. Descriptions are based on information obtained from users and other observers. Therefore, no attempt was made to evaluate this weighing equipment as was done for other scales. It has been reported that users have obtained weighing rates of from 150 to 180 bales per hour with this equipment and a 2-man crew.

Mobile Automatic Scales

In 1955, the authors participated in the testing of experimental automatic scales, mounted on boom trucks, for weighing cotton. The tests were made in cooperation with suppliers of two types of scales, electronic and hydraulic. Two compress plants were used for the experiments, and both flat and compressed bales were weighed. Results showed that at least the electronic scale, with minor changes, could be adapted immediately to mobile weighing methods. Also, results indicated that further studies of both types of scales would be worthwhile. The hydraulic scale tested was not designed for weighing cotton, and was inadequate in several respects. However, if these inadequacies can be corrected, such a scale would offer opportunities for further reducing weighing costs.

During 1955 and 1956, electronic scales were put into use in a number of cotton warehouses. At several warehouses, each scale was mounted on a farm tractor equipped with a boom to which the electronic scale was attached. Hydraulic hooks were used at some warehouses, and hand hooks at others. As a rule, the tractor pulled a small trailer carrying the weighing indicator and a chair and desk for the weigher. At other warehouses, the scales were mounted on industrial boom trucks. At most warehouses, the electronic scales were used to weigh only flat bales. At a few, however, they were used to weigh compressed bales. The procedure successfully followed in weighing compressed bales at one plant was patterned after one developed by the authors. It has not been possible for the authors to make field studies of the weighing methods employed at these plants. However, the reported experiences of the warehousemen concerned indicate that bales can be weighed faster and cheaper with mobile electronic scales than with other current types of weighing equipment.

Other Types of Weighing Operations

In an earlier report (6, pp. 49–51), the methods followed by 2 warehousemen in carrying bales with clamp trucks to and from platform dial scales were described. After some further experimentation, both these warehousemen changed to other methods. The one weighing flat bales changed to portable platform scales fed by hand truck. Apparently both warehousemen concluded that the use of clamp trucks for carrying bales to and from platform scales was less satisfactory for their particular purposes than some other available weighing procedure. It is possible that in other situations different appraisals of such operations might be made.

In 1955, two warehouses were visited in which a newly designed, special type of platform dial scale, fed by clamp truck, had recently been placed in use. The scale is actually a "twin" scale, consisting of two separate, modified platform dial scales set side by side. Each of the two indicating dials faces the weigher-recorder, who stands at a desk between them and observes and records the weights. A clamp truck, carrying 2 bales, sets them down together so that 1 bale rests on 1 platform, and the second on the other. After the weighing, a second clamp truck removes the 2 bales together and places them in a block for sampling. No time studies were made of this weighing operation, so it was not possible to obtain sufficient data for proper evaluation of the work procedure itself.

SAMPLING OPERATIONS[13]

The cotton sampling operation is unique in that it is the one remaining bale-handling operation that is performed almost entirely by hand. The successive sub-operations or elements in the sampling of a bale are: (1) Cutting, (2) trimming, (3) pulling, and (4) wrapping or rolling the sample. Each of these tasks is done by hand. In some plants, the actual cutting of the sample is done with an electric-

[13] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

powered knife, but the knife is applied to the bale by hand; the manual nature of the operation is not basically altered. The possibility of future development of machine methods of sampling of bales should not be overlooked, but many obstacles must be overcome.

Sampling of baled cotton always consists of the same basic elements, but it may differ with respect to (1) organization of the operations, (2) assignment of duties among crew members, (3) time and place at which sampling is done, or (4) time interval between any 2 of its elements. Any one of these factors may affect the efficiency and cost of the operation.

Sampling practices differ between flat and compressed bales. These differences will be discussed later. But sampling practices may differ for other reasons also. The preferences of customers may affect sampling practice. Likewise, the type of sample desired may determine how it is to be drawn and handled. If sampling can be performed at the warehouseman's convenience, he may be able to employ the most efficient sampling methods. In many cases, this cannot be done, however, and the warehouseman is forced to use less efficient methods. Some of the sampling methods that may be used are discussed in this section.

Sampling Bales on Hand Trucks

Generally, bales are sampled while on hand trucks only when they are moved to the sampling operation from some simultaneous operation. The most common case is shown in the following illustration.

Before unloading of bales by machine became widespread, practically all warehousemen used hand trucks for unloading. Moreover, it was a common practice to weigh and sample each bale immediately after its removal from the car or truck. The unloader hand trucked the bale directly to the scale and waited for it to be weighed, then trucked it to a nearby sampling station and waited for it to be sampled. The sample was cut and pulled while the bale remained on the hand truck. The trucker then proceeded to a storage or holding point and unloaded the bale into a block.

While most warehousemen no longer follow that procedure, some, after changing to machine handling, still sample bales on hand trucks.

Samples ordinarily can be drawn from both sides of a flat bale while it is on a hand truck, but from only one side of a compressed bale. As the compressed bale is dumped off the truck into a block, the unsampled underside becomes accessible to the samplers.

To link together unloading, weighing, and sampling in the way described at the beginning of this section often wastes labor unduly because:

1. It is practically impossible to coordinate unloading, weighing, and sampling so as entirely to avoid wait time. It often is extremely difficult, in fact, to keep wait time from being excessive in some phases of the cycle.
2. Unloading is most likely to be the slowest, or "bottleneck," operation. Unloading, therefore, usually sets the pace for both weighing and sampling. The difference between the actual productive sampling time and the unloading time represents wait time for the samplers.
3. While this wait time can be shortened by reducing the size of the sampling crew, it seldom can be eliminated. Moreover, although a smaller sampling crew may reduce its wait time, it may, by lengthening sampling time, increase wait time for unloaders and the scale crew.

An example in the following subsection shows how the cost of sampling bales on hand trucks is increased when the sampling rate is determined by the rate at which bales are received from a preceding "bottleneck" operation.

Sampling Flat Bales

Most flat bales arrive at a warehouse by road truck. In the unloading examples used in the section on unloading, the elapsed time for unloading road trucks onto a dock or platform by hand truck was 0.84 hour. Therefore, for the following illustrations an unloading time of 0.84 hour is used for bales hand trucked 50 feet to a temporary block as they leave the road truck. If both weighing and sampling are introduced into the hand-trucking cycle between the truck and the temporary block, with the same number of hand truckers, the unloading time often is increased. The increase in time results mainly from (1) delay to hand truckers while bales are being weighed and sampled, and (2) increase in distance that hand truckers must travel. Travel distance is increased whenever the block is moved farther away from the truck to allow room for the weighing and sampling stations.

However, the elapsed time of 0.84 hour can be maintained by increasing the number of hand truckers. If enough hand truckers are added, the actual elapsed time for sampling—counting both work time and wait time—also is 0.84 hour, the same as for unloading. In this operation, both unloading and weighing can be done in 0.84 hour without adding a hand trucker to the 2 needed for unloading. However, if sampling on hand trucks is added to this combination, a third hand trucker is needed to complete all 3 operations in 0.84 hour.

The 6-man crew in the following illustration is comparable to those used at several warehouses where sampling on hand trucks was studied. Their duties, and the actual work time

per 100 bales required by each man, are as follows: (1) One worker cuts and pulls the sample on 1 side of the bale (0.45 hour); (2) a second worker takes the sample on the other side (0.45 hour); (3) a third worker, at the block, trims the cut on one side of the bale (0.21 hour); (4) a fourth worker trims the cut on the opposite side of the bale (0.21 hour); and (5) the fifth and sixth workers trim and wrap samples, and drop them into a container (0.31 hour each). This represents 1.94 man-hours of productive time, and therefore a labor cost of $1.94 for the actual sampling work done. To this must be added the cost of wait time, noted below.

The two cutter-pullers require more time than any other members of the sampling crew (0.45 hour). Therefore, 0.45 hour represents the minimum time required for sampling by the entire crew if sampling were continuous, and if samplers obtained bales as fast as they could handle them. Even under ideal conditions, some members of the sampling crew have wait time. Hand truckers also are delayed at least 0.45 hour while waiting for bales on their trucks to be sampled.[14]

When sampling by a 6-man crew takes 0.45 hour, 2.70 man-hours (6 times 0.45 hour) are expended. But the total of 2.70 man-hours (productive and nonproductive), and the total costs, $2.70, do not apply where the sampling rate is dependent on the unloading rate. Then the total elapsed time for sampling (including both work time and wait time) is really 0.84 hour, the same as for unloading. Thus, the sampling crew actually spends on the job 6 times 0.84 hour, or a total of 5.04 man-hours of productive and nonproductive time. The cost of this method of sampling, therefore, is computed at $5.04. This represents an increase of about 87 percent over the direct costs of sampling because of the added wait time. In addition, there would be justification for adding to the 5.04 man-hours the 0.45 man-hour of each hand trucker's time spent waiting at the sampling station plus some allocation of the trucker's travel time. This would raise the cost at least an additional $0.50. For purposes of this illustration, however, this was not done.

The costs of sampling on hand trucks can be reduced substantially by reducing the "typical" crew size and changing its work organization. In this particular situation, the best crew size is 3 workers, the smallest that can complete the sampling within 0.84 hour. Both experience and analysis have shown, however, that the best way of improving this type of sampling is to change the procedure. The warehouseman should try to avoid the sampling of flat bales on hand trucks. In most warehouses, large or small, block sampling can be used for flat bales and probably is much less expensive.

[14] It will be recalled from the preceding section that tags are tied on by the hand trucker during the weighing operation, and, in many warehouses, while he is waiting at the sampling station.

Sampling Compressed Bales

As mentioned before, only one side of compressed bales is sampled on hand trucks. The second side is sampled after the bale has been placed on head in the block. One or more workers are stationed at the block for this purpose. About one-fifth less time is required to cut and pull a sample from a compressed bale than from a flat bale. The sample is more likely to be rolled, which takes much less time than wrapping it.[15] Otherwise, the sampling procedure is much like that for flat bales.

Block Sampling

Block sampling is the sampling of bales while positioned in a permanent or temporary sampling block. Flat bales are especially suited to block sampling. Row-type blocks are ideal for this purpose, and are commonly used. Compressed bales, because they sometimes have a tendency to fall over when unsupported in an on-head position, are not as well suited to block sampling as flat bales. Progress has been made, though, in adapting block sampling to compressed cotton. In some operations, in fact, compressed bales have been sampled in row-type blocks in much the same way as flat bales. Further research and experimentation are needed in this area.

Sampling Flat Bales

The most common form of sampling block for flat bales is the single row. Where mobile scales are used, the row block serves first as a weighing block. Then, as a sampling block, it provides a means for efficient and economical sampling by a roving crew. Although usually desirable, it is not necessary that bales be placed in rows for sampling. Individual bales, if spaced loosely enough within a limited area, may be block-sampled. This may be done, for example, where working space is at a premium and sampled bales must be removed from the sampling area as quickly as possible. A major difficulty with this procedure is that sampling is likely to be paced by some other operation, and thus may

[15] Whether samples are rolled or wrapped depends mainly on the preferences of the owner of the cotton. In a given load of flat bales received from a gin or country warehouse, many different owners may be represented; then individually wrapped samples usually are desired. Compressed bales usually are received in lots, each belonging to a single owner; then it may be more desirable to roll and sack samples from the lot for delivery as a unit.

lose both speed and efficiency. The discussion in this subsection, will be limited to the sampling of row blocks.

As pointed out, the elapsed time for sampling on hand trucks usually is determined by the elapsed time for an operation with which it is linked. However, block sampling of flat bales in row blocks can be speeded up or slowed down without regard to the speed of other operations, simply by changing the crew size or redistributing the sampling duties. How this may be done is illustrated in some of the following examples.

A sampling procedure typical of a number observed involves a 7-man crew: (1) 2 cutters, who work together but on opposite sides of the row; (2) 2 pullers, who also work on opposite sides; (3) 2 trimmers who, working in like manner, trim the cuts made in the bales by the cutters; and (4) 1 wrapper, who also trims the samples and places them in containers.

It is not necessary that this crew work together. If conditions permit, each task can be performed independently of the others, except for the order in which the tasks are done. Cutting, for example, may be done well in advance of pulling. Wrapping can be done at any convenient time after pulling. Trimming sample cuts may take place either before or after wrapping. In some warehouses the trimming job is eliminated. The relative elapsed times for these tasks, including movement of workers from bale to bale, when 1 worker performs each task, are shown in figure 21. When these tasks are distributed among a 7-man crew as outlined above, the elapsed work time for each task is as follows:

(1) Cutting (2 workers)	0.14 hour
(2) Pulling (2 workers)	.26 hour
(3) Trimming (2 workers)	.21 hour
(4) Wrapping (1 worker)	[16].62 hour

[16] If samples are rolled rather than wrapped in paper, 0.35 instead of 0.62 hour is required. This difference in time may affect the crew size and elapsed time that are most economical for a given situation.

On the basis of work time alone, then, 1.84 man-hours of labor are required. This represents a cost of $1.84 for the actual sampling done.

It is correct also to figure the total cost of sampling this way if, as each worker finishes his particular sampling duties, he is assigned other duties. Preferably, of course, when any worker finishes his sampling tasks ahead of others, he should then help the others to complete their tasks. In this way, wait time often can be substantially reduced, though it may not be eliminated. Wait time can be eliminated only when each sampling task can be performed independently of the others, or when the sampling procedure can be organized to achieve perfect balance. While perfect balance may rarely exist in practice, the warehouseman, by sampling in row blocks, often is able closely to approximate such conditions.

On the basis of these times (listed above) for various sampling tasks, the direct labor requirements for block sampling, excluding wait time, are 1.84 man-hours per 100 bales. When the various sampling jobs are performed independently or when there is a perfect balance of activities, wait time may be almost eliminated; then the total labor requirements for sampling also are 1.84 man-hours.

The time required for completing a sampling job, where block sampling is used, depends mainly on the size of the crew. But it also depends on how efficiently the crew activities are organized. Both factors, size and organization, are under the control of the warehouseman, who can regulate, within limits, the sampling rate and the efficiency of the sampling operation.

Efficiency is easier to obtain in block sampling than in most other crew-performed operations. Crew activities need not remain unbalanced simply because the different sampling tasks (cutting, pulling, trimming, wrapping) take unequal times to complete. Balance can be achieved, or closely approached, by following this simple rule: When any crew member finishes his own assigned tasks, he should assist other crew members with their tasks, until all tasks are completed. There are various ways of getting balance, since there are various ways of assigning duties. There is little difference among them in final outcome.

A few examples are discussed here. To simplify the examples, 4 assumptions were made: (1) Exactly 100 bales are sampled; (2) the sampling times listed previously hold uniformly for all workers throughout the operation; (3) times remain the same for each task regardless of how such tasks are combined; and (4) the procedures followed, and the layout of the row block or blocks, are such that crew interference, time in shifting tasks, and other such factors have negligible effect on elapsed time and can therefore be disregarded.

One-man crew.—Several alternative procedures are open to the one-man crew in block sampling. For example, he can do the operation as follows: (1) Pass down one side, cutting samples from all bales, then return down the opposite side, cutting samples from all bales (2 times 0.14, or 0.28 hour); (2) pull samples the same way (2 times 0.26, or 0.52 hour); (3) trim sample cuts the same way (2 times 0.21, or 0.42 hour); and (4) wrap all samples and place them in containers (0.62 hour). The total elapsed time for a 1-man crew, then, is 0.28 plus 0.52 plus 0.42 plus 0.62, or 1.84 hours, with a sampling rate of 54 bales per hour.

There are several other procedures the sampler can follow, of course. He can cut and pull;

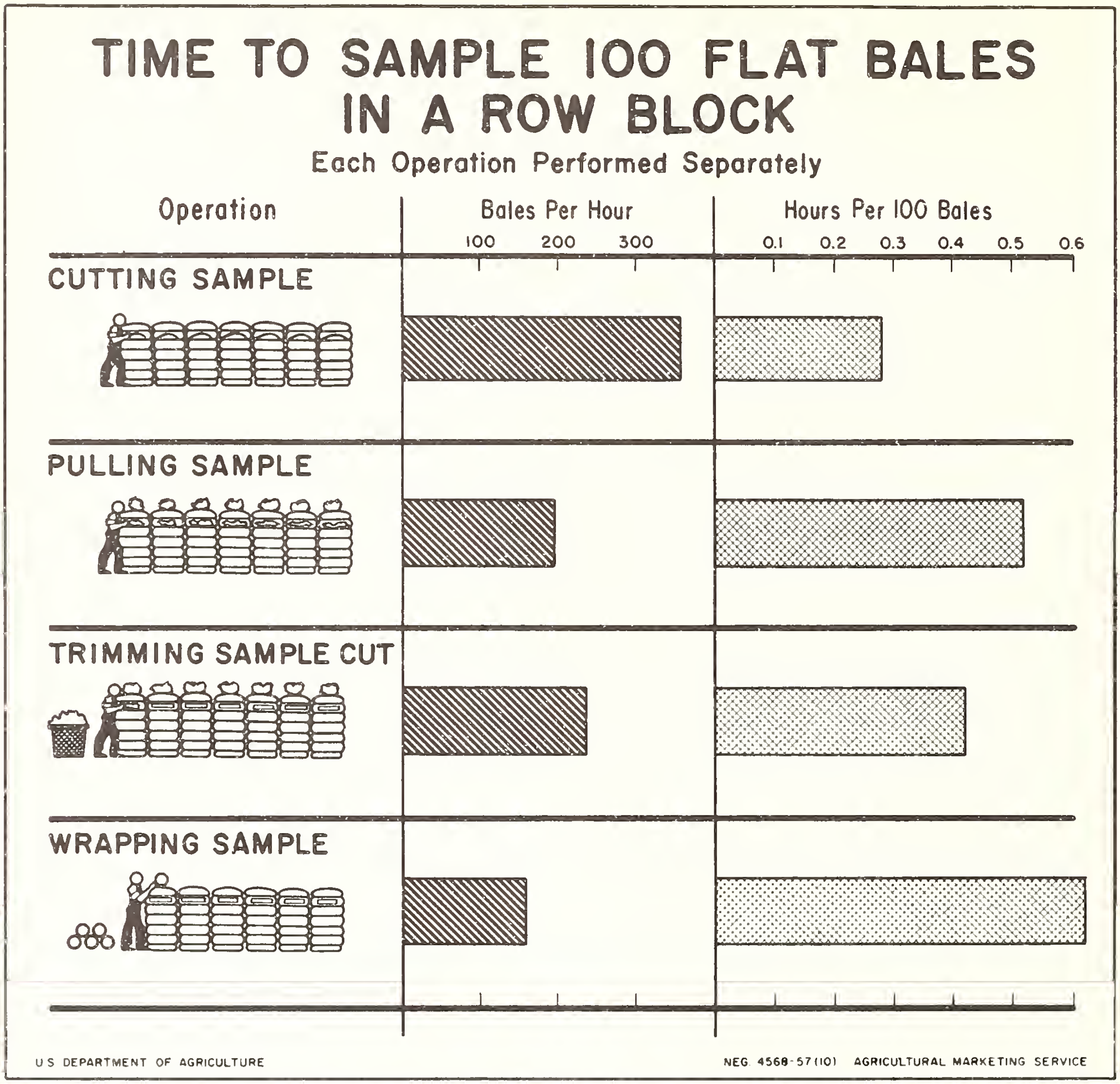

Figure 21.

pull and trim; or cut, pull, and trim, on one side of each bale in turn. To do some of these jobs in sequence on each bale may save time in moving from bale to bale. But for the purposes of this discussion it is assumed, as stated earlier, that such variations in procedure do not affect the time requirements.

Two-man crew.—When 2 men are used, 1 man can work down 1 side of the row while the other works down the other side. This gets the job done twice as fast, cutting elapsed time from 1.84 to 0.92 hour. Total requirements are, of course, the same as before, or 1.84 man-hours, with a sampling rate of 108 bales per hour.

Three-man crew.—A 3-man operation cannot be precisely balanced for a 100-bale lot, but in practice it is as likely to balance out as is an operation with a crew of any other size. If 2 of the 3 crew members should cut, pull, and trim while the third member simultaneously wraps, the entire crew should proceed at about the same rate throughout the operation. Cutting, pulling, and trimming, when done by 2 workers, takes 0.14 plus 0.26 plus 0.21, or a total of 0.61 hour, with a sampling rate of 162 bales per hour. Wrapping, when done by 1 worker, takes 0.62 hour.

Four-man crew.—Often the best and usually the simplest way to organize a 4-man, 6-man, or 8-man crew is to split it into a number of 2-man crews. As a rule, small crews have better coordination and less wait time from crew interference and other causes, and therefore are able to work more efficiently. But there are several ways to coordinate the activities of a 4-man crew working together as a single sampling team. One such way is explained in detail, since it illustrates the manner in which coordination may be achieved in a crew of any size.

Under this procedure: (1) 2 men cut samples from all 100 bales in the lot; (2) the other 2 men, following behind the 2 cutters, pull samples and trim the sample cuts; (3) when the 2 cutters finish cutting, they assist the puller-trimmers; and (4) when trimming is completed, all 4 workers wrap samples. When the 2 cutters have completed cutting samples from all 100 bales, the other 2 workers will have pulled samples and trimmed sample cuts from 30 bales. The remaining 70 bales can be handled in 0.16 hour if all 4 workers pull and trim. So, at the end of 0.30 hour, cutting, pulling, and trimming will have been completed on the entire 100-bale lot, leaving only wrapping to be done. With 4 men wrapping, 100 samples can be wrapped in 0.16 hour, making the total sampling time 0.46 hour. Again, as with other crews, the total labor requirements are 1.84 man-hours, with a sampling rate of 216 bales per hour.

Five-man and larger crews.—As a rule, the work of 5-man and larger crews should be organized on the basis of either 2-man or 4-man crews. As stated before, separate small crews are usually better than 1 large crew. When a large crew is used, it usually is better to begin with these 3 basic groups of workers: (1) Cutters (2 men), (2) trimmer-pullers (2 men), and (3) wrappers, (1 or more men). Some prefer 4 groups, such as were used in the typical 7-man crew described previously. When each group can work independently, this grouping is as good as any. But if they should work together as a unit, the trimmers, although able to do their job in 0.21 hour, are required to conform to the slower rate of the pullers, who require 0.26 hour. This is because a sample cut obviously cannot be trimmed until the sample has been pulled from the bale. In assigning crew members to any specified duties, care should always be taken that bottlenecks of this sort are not needlessly created. The number of bales sampled per hour by crews of different sizes is shown in figure 22.

Sampling Compressed Bales

Progress has been more limited in adapting block sampling to compressed bales. Most such sampling is performed in conjunction with another operation, such as weighing.

Compressed bales can best be sampled as they are withdrawn from or placed in a block. It is easier then to obtain access to both sampling sides so the entire sampling job can be done at one time at either block. The sampling rate can be increased considerably, however, without increasing crew size, by splitting up the job between the two blocks.

One method of doing this is as follows: As bales are withdrawn from a block, one worker cuts and pulls a sample from the exposed side of the bale, and then turns the bale around so that the uncut side faces outward. A second worker trims the sample cut. A hand trucker then loads the bale onto his truck, uncut side down, and moves it to a second block. When the hand trucker unloads the bale into the second block, the uncut side again faces outward. Here a third sampler cuts and pulls a sample from the remaining side. A fourth worker trims the sample cut, and a fifth worker rolls the samples and places them in a sack or other container.

The worker whose job takes the longest is the one who, at the first block: (1) Cuts, (2) pulls, and (3) turns the bale around. His elapsed work time is 0.48 hour per 100 bales. This worker and the trimmer try always to keep one or two bales ahead of the hand truckers. Thus, unless influenced by some other related operation, the elapsed time for the complete sampling operation becomes 0.48 hour. The difference between 0.48 hour and the time required for the jobs of the 2 trimmers (0.21 hour each) the cutter-puller at the second block (0.37 hour), and the roller (0.35 hour) represents wait time for them.

If block sampling were simply a matter of hand trucking bales directly from one block to the other, without weighing them en route, the efficiency and speed of this operation could be greatly increased. But block sampling, performed independently of other operations, is not likely to be used so long as compressed bales are hand trucked to and from a block and the beam or platform scale. Block sampling of compressed bales usually is done only in connection with some other operation; therefore, the rate of flow of bales from or to the blocks affects the sampling rate. If this rate is greater than 100 bales in 0.48 hour (the time for the sampler whose job is longest), the elapsed time for sampling remains at 0.48 hour; this time then becomes the elapsed time for the other operation also. If the rate is less than 100 bales in 0.48 hour, the total time for sam-

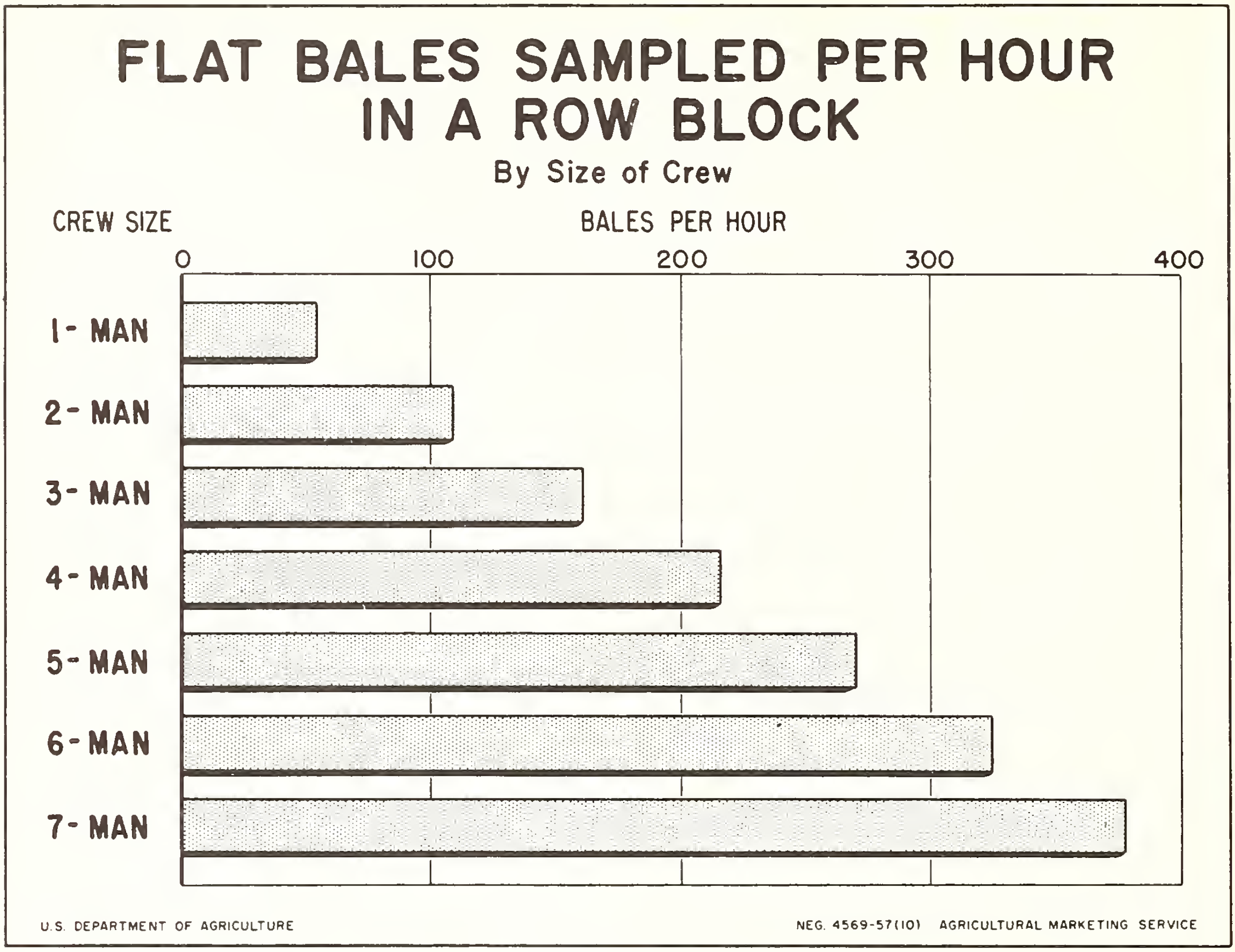

FIGURE 22.

pling is increased by the building up of wait time for the samplers, to correspond with the rate of flow.

Sampling in conjunction with weighing.—Most methods of block sampling for compressed bales tie in sampling with weighing by hand truck. The slower operation, weighing or sampling, then determines the elapsed time for both operations. The most desirable situation, of course, is that in which both operations are so organized—mainly by varying crew size and assignment of duties—that if done independently they would take about the same time.

For example, suppose that sampling by a 5-man crew, as described above, is merged with weighing with a portable platform scale by a 2-man scale crew and 4 hand truckers. Weighing with this crew can be done in 0.46 hour, if done independently of other operations.[17] Since sampling can be completed in about 0.48 hour, combining it with weighing should not create much additional wait time for the weighing crew. The added wait time results from increasing the total weighing time from 0.46 to 0.48 hour, as determined by the slightly slower sampling rate. The total cost of weighing and sampling, on the basis of assumed wage rates is $3.79 (for weighing) plus $2.40 (for sampling) or $6.19.

If in any situation either sampling or weighing should substantially slow the other, it might be desirable to do one or both of two things: (1) Increase the size and reassign duties of the crew performing the bottleneck operation in order to speed it up, or (2) decrease the size and reassign duties of the crew performing the faster operation to conform to the lowered rate of handling.

Also, because of varying wage rates and equipment costs included in the weighing operation, the effects of any merger of the two opera-

[17] The weighing operation with this crew and equipment discussed in the section on weighing dealt with flat bales. In later discussions, the same weighing time is used for compressed bales.

tions must be measured in terms of dollar cost instead of solely in man-hours of labor.

The net effects on elapsed time and on cost of the variations in the size of the weighing and sampling crews are summarized in figure 23.

Sampling in conjunction with unloading.—The sampling of compressed bales has been discussed in terms of its relation to a simultaneous weighing operation. It is possible, of course, for sampling to be joined with some other receiving operation, as, for example, unloading. The elapsed time for unloading a car by clamp truck does not differ greatly from that for sampling with a 3-man crew. Thus, the two

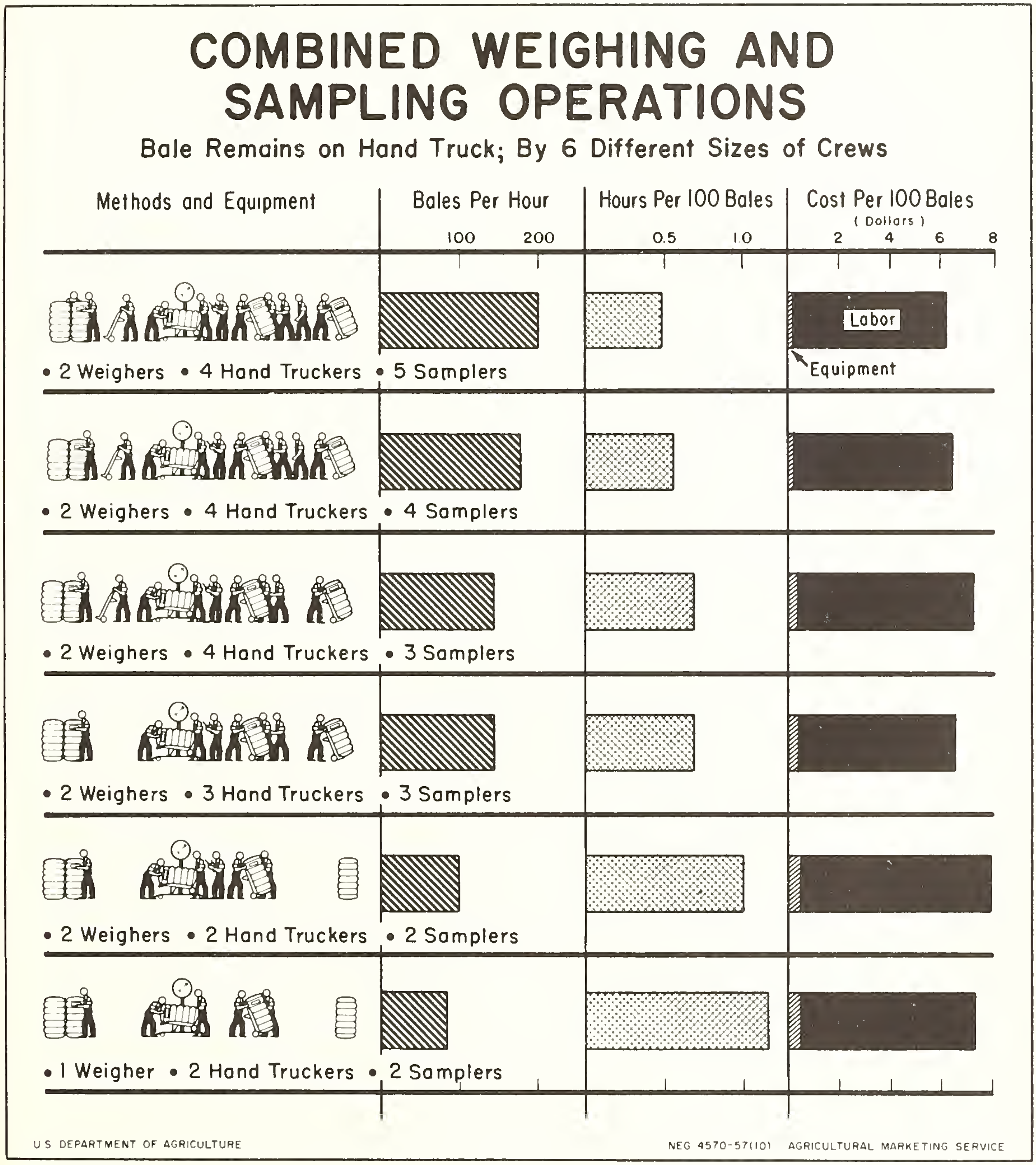

FIGURE 23.

operations often can be joined, much as are weighing and sampling.

The 2 operations are combined as follows: (1) The clamp truck unloads the car and brings 2 bales at a time to a temporary block on the receiving apron near the car; the bales are set down on the edge of the block but are not pushed tightly into it; (2) 2 samplers receive each pair of bales and each sampler cuts and pulls a sample from 1 side of 1 of the bales, trims the sample cut, and twists the bale about 10 to 20 degrees to expose the uncut side; each sampler then draws a sample from the second side in the same manner. Generally, the samplers have time also to roll the sample; if not, this can be done by a third worker either during the unloading or after the bales have been weighed.

Where the samplers are also able to roll samples during the unloading, this method is often cheaper than other methods. For example, if 100 compressed bales are unloaded and completely sampled in 0.81 hour, the sampling requires 1.62 man-hours of labor, and costs $1.62. The time for collecting the samples from the tops of the bales immediately after weighing and for placing them in a sack is disregarded, since this usually can be done by a member of the weighing crew during moments when he is otherwise idle.

Sampling independently of other operations.—Compressed bales unloaded into a loose block, with some space between most pairs of bales, often can be sampled while in this block. The best type of block for this purpose is a row. The procedure is similar to that used when sampling bales at the time of unloading. The sampler moves or turns the bale as necessary to obtain access to each side. One or more samplers can be assigned to the job, depending on the sampling rate desired. The advantages of this method, where it can be used, are: (1) It permits sampling at any convenient time instead of only when certain other operations are done; (2) it prevents sampling from becoming a bottleneck for some other operation, or vice versa; and (3) it permits flexibility in the size of the sampling crew without appreciably affecting the cost.

Occasionally, handling compressed bales in a row block or other temporary block may cause a bale or two to fall. Samplers usually can prevent this by watching for bales tending to topple, and leaning them against each other as they finish sampling them. Except in unusual situations, any time lost in setting erect fallen bales is likely to be negligible.

STORING OPERATIONS[18]

Storing operations are those required in placing bales in a stack or other type of block for permanent storage. The terms "storage arrangement" and "storage pattern" refer mainly to the height, shape, and general composition of such stacks and blocks. For example, 2 common storage patterns for flat bales are: (1) On head in solid blocks 1 bale high; and (2) on head in pairs of rows 2 bales high, spaced by lateral aisles.

Warehousemen do not necessarily use the same storage patterns from season to season. They may even change them during a single season. But the warehouseman's objective remains the same: To use that pattern which will minimize his handling costs while still providing space for all the bales he expects to store. Frequently, a change is made because the old pattern no longer provides the storage capacity needed. In such cases, the warehouseman may be willing to assume heavier handling costs in anticipation of increased revenues from storage; or he may wish to avoid having to turn away business, and may regard the higher costs simply as a necessary expense to insure retention of the good will of his customers.

[18] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

Storage Arrangements Commonly in Use

In determining the pattern to use, a warehouseman takes into account: (1) The structural strength of floors and platforms in the storage area; (2) the maximum number of bales, flat or compressed, he expects to store at any one time; (3) the anticipated period of storage; (4) the storing method and equipment required; (5) the breakout method and equipment required; and (6) comparative storing and breakout costs for alternative storage patterns.

In general, both flat and compressed bales may be stored on head in solid blocks, 1 bale high. Flat bales may be stacked on head in rows, 2 or 3 bales high, or on side in cordwood stacks 4 to 7 bales high. In either case, pairs of rows, or blocks of other sizes, may be spaced by lateral aisles. Compressed bales often are "cordwooded" 4 to 6 bales high. For storing in solid blocks 1 bale high, hand trucks or clamp trucks can be used. For stacking 2 or more bales high, manual and hand-truck fork trucks,

portable elevators, boom trucks, and clamp trucks can be used.

Manual methods, hand trucks, portable elevators, and fork trucks are generally being replaced by lift trucks using bale clamps or other specially designed cotton-handling attachments. By using clamp attachments, a warehouseman can substantially reduce crew sizes, man-hours, operational costs, and elapsed time.

Cordwood Storage

An assumed transport distance of 50 feet from the temporary block in the main aisle to the stacking area is used in the description of methods for stacking bales in cordwood fashion.

Flat bales.—Few warehousemen stack flat bales in cordwood stacks by manual methods. Not only is it a backbreaking operation, but it also costs more and takes more time than any other method. In building a stack 5 bales high, a 10-man crew of 9 stackers and hand truckers may be used. The stackers manually lift and roll bales into position in the stack. Such a procedure requires an estimated 5.21 hours per 100 bales. Thus, the job requires 52.10 man-hours of labor at a cost of $52.15 (fig. 24).

Some warehousemen, when stacking from an aisle already closed in by stacks on one or both sides, use a semi-manual method, in which boom trucks are used in conjunction with hand labor to store bales in cordwood stacks. This method is much faster and much cheaper than the manual method described, though less efficient than the clamp-truck method next to be described. Where stacking must be done in narrow aisles, however, it often is more practical to use a boom truck than a clamp truck. The job usually requires a 5-man crew, consisting of 1 boom-truck operator, 2 stackers or hookmen, and 2 hand truckers. This method is similar to that for stacking compressed bales described

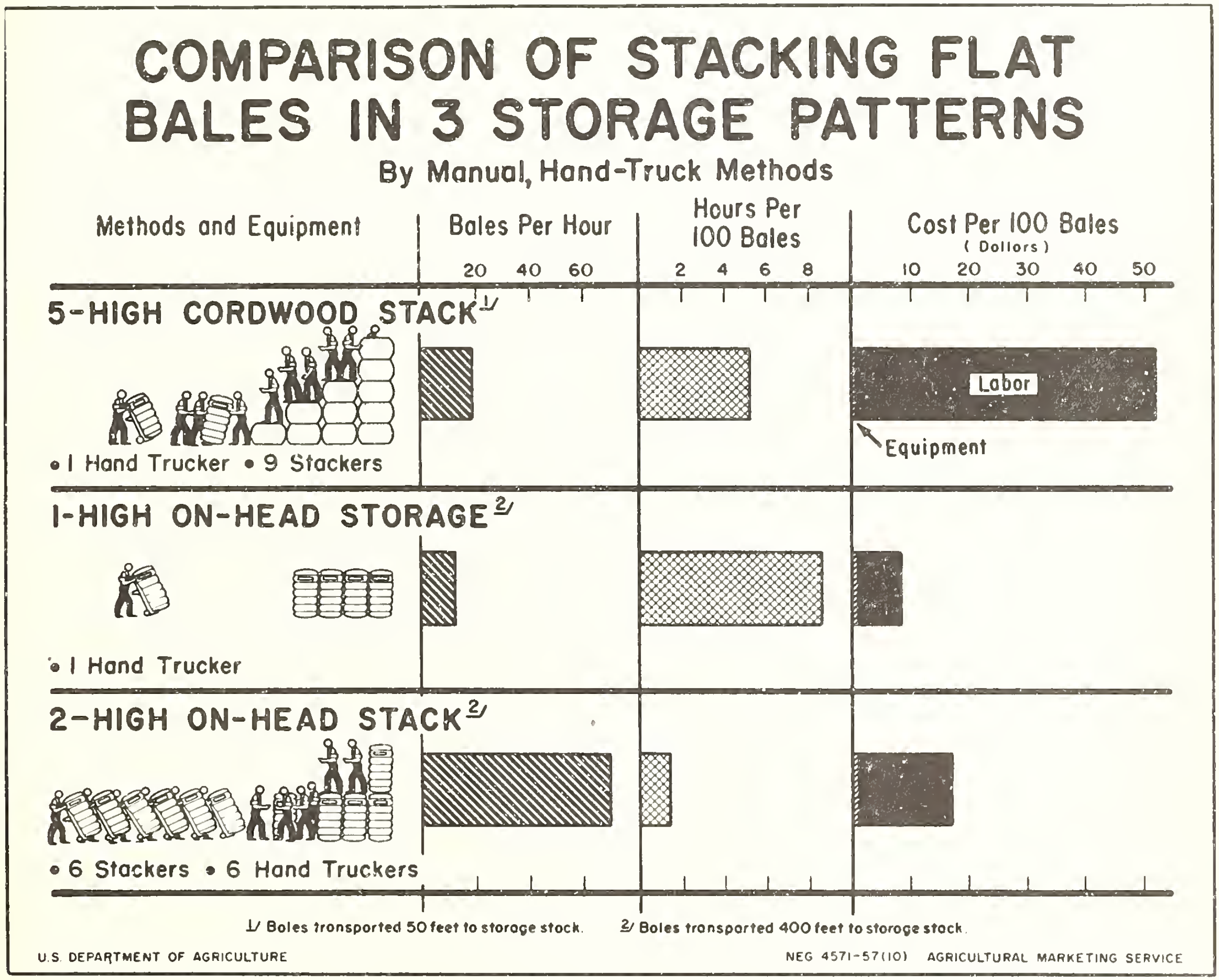

FIGURE 24.

in an earlier report. (2). In that report, however, the 2 hand truckers were not treated as part of the stacking crew, as they are here, but as part of a separate "transporting" crew. Hence, the stacking crew was shown to consist of 3 rather than 5 workers.

Other warehousemen, in stacking from an uncongested area, use clamp trucks. The 3-bale clamp truck is especially well adapted to such an operation. Before stacking, bales are usually delivered to the stacking area and set down on head in temporary blocks. Then the clamp truck pushes or pulls 3 to 5 bales over onto their first flat sides. Next the truck piles 3 bales, 1 on top of the other, into a single column. It then picks up and carries the entire column to the stack, and sets it down on the floor as part of the stack. The truck then returns to the assembly point, and in a similar manner builds a column 2 bales high. The 2-bale column is then placed on top of the 3-bale column previously placed. By continuing this procedure, the clamp truck completes the 5-high cordwood stack. One 3-bale clamp truck requires about 1.08 hours, at a total cost of $2.81, to stack 100 bales. A 2-bale truck, building the stack by first placing a 2-high column of bales on the floor, and then placing in succession on top of this another 2-high column and then a 1-high column, and continually repeating this sequence, takes about 1.65 hours, with a cost of $4.04 (fig. 25).

Many warehousemen use a larger crew or a less efficient but faster method simply to gain speed in stacking. However, there is at least one other factor to be considered. That is the cost of wait time between jobs. For example, flat bales are not usually received at a warehouse in a continuous, even flow. If stacking crews depend on the flow of receipts to provide them with work, they often have wait time. It is much cheaper, of course, to have 1 man and a

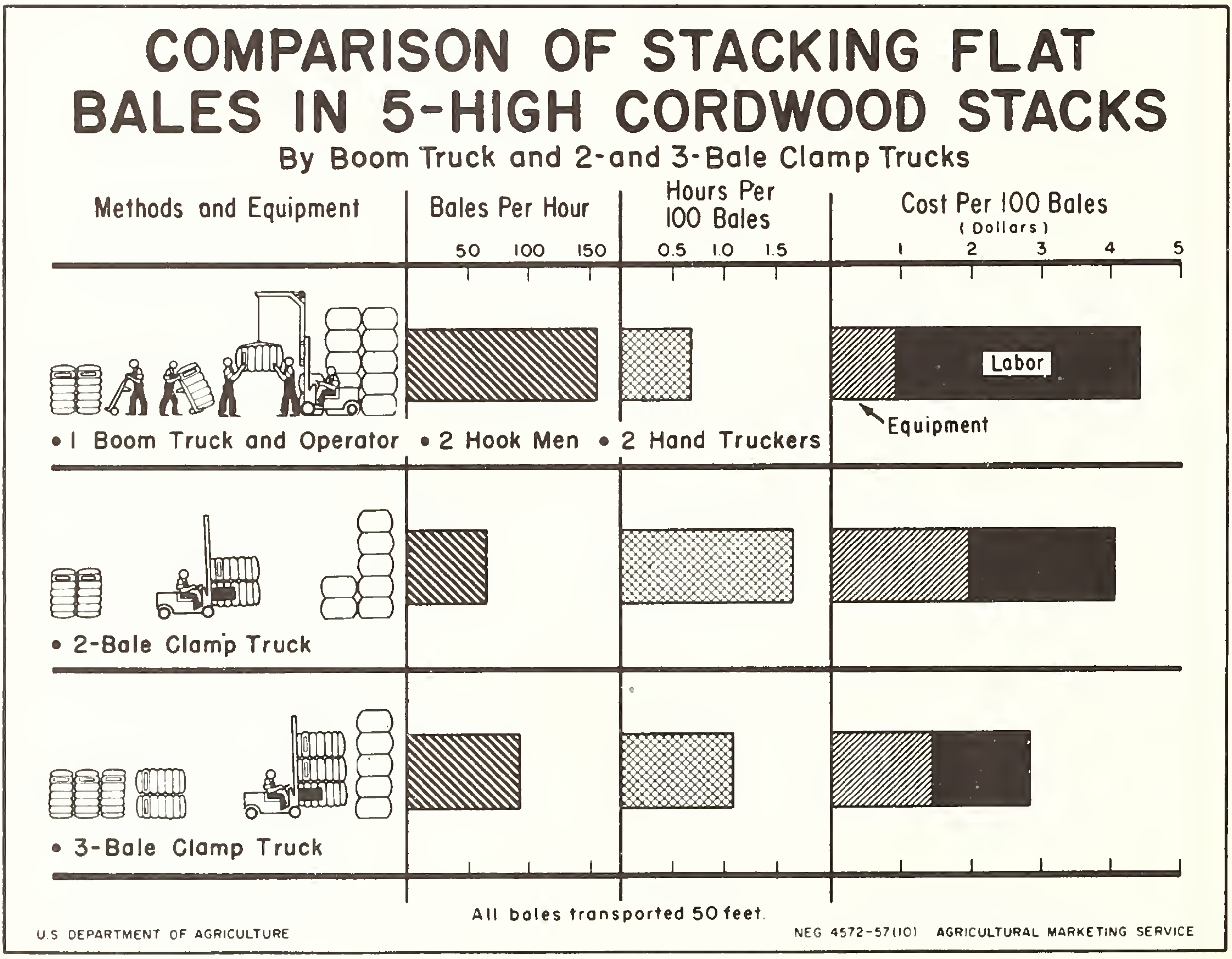

FIGURE 25.

machine idle than, for example, 5 men and a machine, such as were used in the manual and boom-truck method.

Compressed bales.—It is a practice in most warehouses, when there is a shortage of space, to store compressed bales in cordwood stacks. For purposes of comparison, a stack 5 bales high, which is common, is assumed. Using the manual and boom-truck method previously described for cordwooding flat bales, a 5-man crew requires 0.66 hour. Thus, stacking by this method requires 3.30 man-hours of labor, and has a labor and equipment cost of $4.41 (fig. 26).

Clamp trucks can be used in many warehouses for storing compressed bales in cordwood stacks. Using a 2-bale clamp truck requires 0.87 hour for stacking, with a cost of $2.13. Using a 3-bale clamp truck requires 0.69 hour, with a cost of $1.79.

Where bales are stacked immediately after compression, the compressing rate often controls the stacking rate. The compressing rate at most warehouses averages from 100 to 110 bales per hour. Thus, the stacking rate tends to average the same, if stacking immediately follows compressing, and idle time may result for the stacking crew, thus increasing the cost. It is desirable, therefore, to use the smallest crew and the lowest cost equipment possible, as seen from the following comparisons of methods. The manual and boom-truck method, with a 5-man crew, is used at many warehouses to cordwood compressed bales. When this method is used, bales can be stacked at the rate of about 145 bales per hour, which greatly exceeds the rate at which bales can be received from the press. If such a crew is limited, because of the pressing rate, to stacking 100 bales per hour, the cost of stacking is increased from $4.41 to $6.67. On the other hand, a 2-bale clamp truck is capable of stacking about 115 bales per hour. This, too, exceeds the press rate. However, if this truck is similarly limited to stacking at the

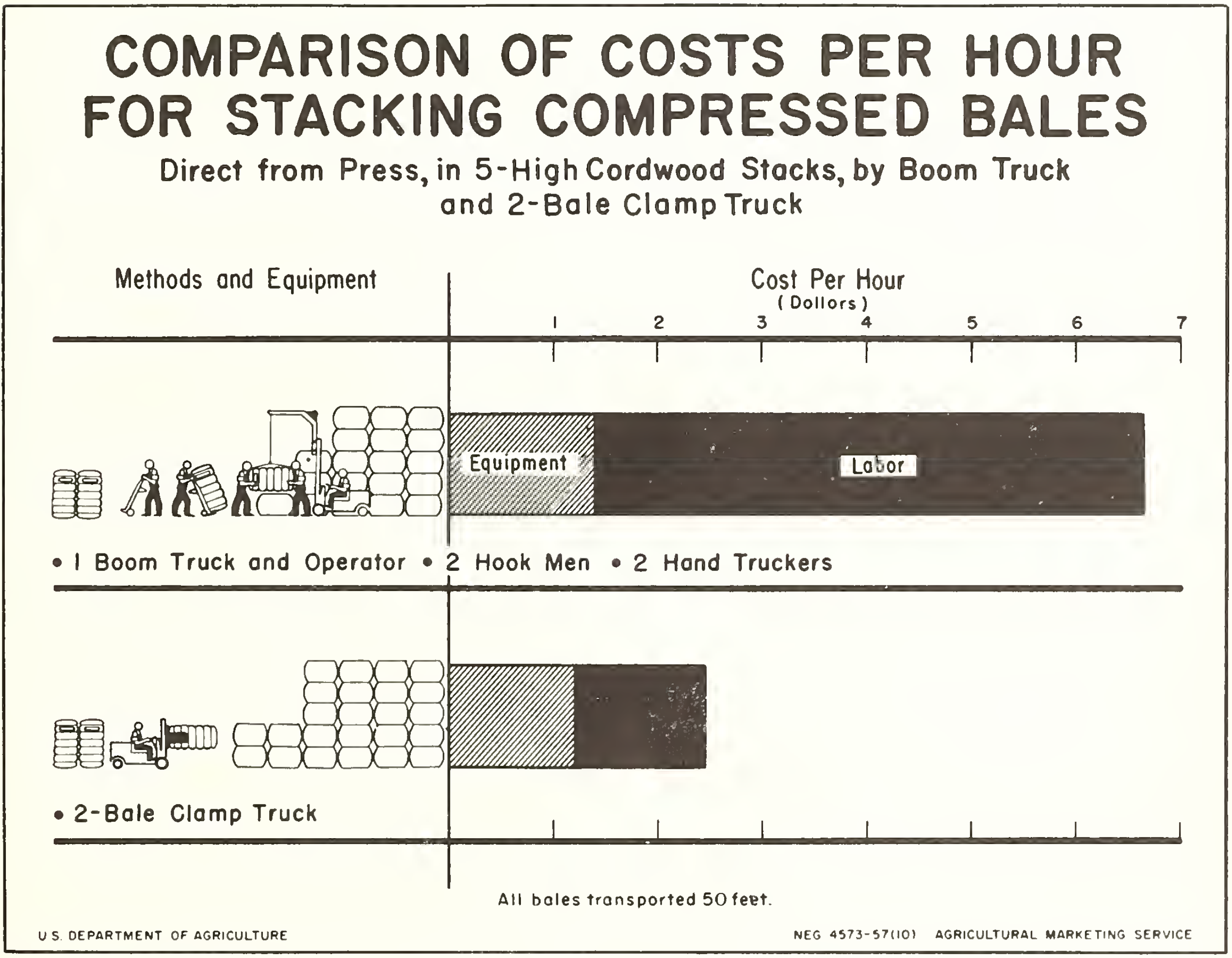

FIGURE 26.

rate of 100 bales per hour, the cost of stacking is increased only from $2.13 to $2.45. This latter method, compared with the manual and boom-truck method, thus results in a saving of $4.22 in the cost of stacking (fig. 26).

Normally, at the beginning of the season, most compartments in country warehouses are empty, or almost so. In many of these warehouses, then, clamp trucks may be used for stacking for much of the season, or until all compartments are filled. However, in many concentration compresses and warehouses, it might not be possible to use clamp trucks regularly for cordwooding bales. Such plants usually receive and ship bales the year around and generally handle a volume equal to two or more times their rated capacities. Compartments are seldom completely empty and frequently lack the maneuver room that a clamp truck requires.

Before the start of the cotton season, warehousemen try to make room for the new crop by tightening up stacks in each compartment. This work often has to be done in areas where a clamp truck would not have room to maneuver, and boom trucks must be used for both tightening up and stacking.

On-Head Storage

Some warehousemen store both flat and compressed bales on head 1 high in solid blocks. Others store flat bales in 2- or 3-high stacks, usually in paired rows separated by cross aisles. Compressed bales when stacked are, as already noted, usually cordwooded.

Hand trucks are often used in the smaller warehouses for storing bales 1 high. But such equipment has been replaced in many warehouses by clamp trucks. In the larger warehouses, in fact, the stacking of flat bales is done almost exclusively by clamp trucks.

The relative efficiency and cost of several typical methods will now be discussed. In all the computations for the various methods discussed, it was assumed that the storing crew works from a temporary block in the receiving area rather than in the storage area. A standard transport distance of 400 feet from the block to the storing point was assumed for all methods, rather than the 50 feet assumed for bales that were cordwooded. Bales to be stored on head are usually stored directly by the transporting equipment (hand truck or clamp truck) before the equipment returns to the receiving area for another load. An exception to this rule occurs when bales are brought to the storage area by tractor-trailer train. Bales then may be unloaded from the trains into a temporary block, as discussed previously, and then placed in storage from that block.

Storing flat bales 1 bale high.—The most common form in which flat bales are stored 1 bale high is the solid block. Formerly, before the advent of the powered industrial lift truck, flat bales often were stored 1 bale high in paired rows separated by cross aisles. But with powered equipment, bales stored in paired rows are more likely to be stacked 2 or 3 bales high.

The most efficient way to store flat bales in 1-high blocks is to use a clamp truck that can carry the largest possible number of bales as a unit. Therefore, a 6-bale clamp truck, where it can be used, is the most efficient equipment currently available to pick up, transport, and store bales in 1-high blocks. The elapsed time per 100 bales, for transporting 400 feet and storing 1 bale high, is 0.33 hour. Thus, storing bales with this truck involves a labor and equipment cost of about $1.15 (fig. 27).

The next most efficient method is to use a 4-bale clamp truck, with which elapsed time is 0.46 hour, and cost is $1.40.

A 3-bale clamp truck requires 0.85 hour, with a cost of $2.21. A 2-bale clamp truck requires 1.20 hours, with a cost of $2.94.

Using hand trucks is the most expensive of all methods. It takes 1 hand trucker 8.60 hours to transport and store 100 bales at a distance of 400 feet. This results in a labor and equipment cost of $8.69 (fig. 24). To approximate the production rate of a 2-bale clamp truck at this distance requires 7 hand truckers.

Stacking flat bales 2 bales high.—Flat bales are often stacked 2 high on head in paired rows so that a lift truck with a breakout device can be used. Also, some warehousemen use this stacking pattern when bales are to be pressed just before shipping.

The most efficient method for transporting and stacking flat bales 2 high on head in paired rows is to use a 4-bale clamp truck.[19] Elapsed time for this method, at 400 feet, is 0.52 hour, with a cost of $1.59 per 100 bales. Bales can be transported and stacked at a rate of 193 bales per hour.

A 3-bale clamp truck requires an elapsed time of 0.93 hour, with a cost of $2.41. Bales can be moved and stacked at a rate of 107 bales per hour.

A 2-bale clamp truck requires 1.26 hours of elapsed time with a cost of $3.08. Bales can be stored 2 bales high at a rate of 79 bales per hour.

The most inefficient method is to use hand trucks to transport bales to the stack and have

[19] In some instances, a 6-bale truck might successfully be used. In many situations, however, there is not enough room to maneuver the larger truck. In addition, the heavier loads frequently cause the truck to become unstable when bales are lifted to the height necessary to place them in the upper tier.

workers lift the bales into the second tier by hand. A 12-man crew, consisting of 6 hand truckers and 6 stackers, takes somewhat longer to transport and stack than a 2-bale clamp truck. A crew of this size requires an elapse time of 1.43 hours and 17.18 man-hours of labor at a total cost of $17.27 (fig. 24).

Stacking flat bales 3 bales high.—Where flat bales can be stacked 3 high on head, a warehouseman may be able to use 2-, 3-, or 4-bale clamp trucks. A 4-bale clamp truck can carry, lift, and stack more bales as a unit, and is the most efficient of the 3 sizes. A 4-bale truck requires 0.59 hour for transporting and stack-

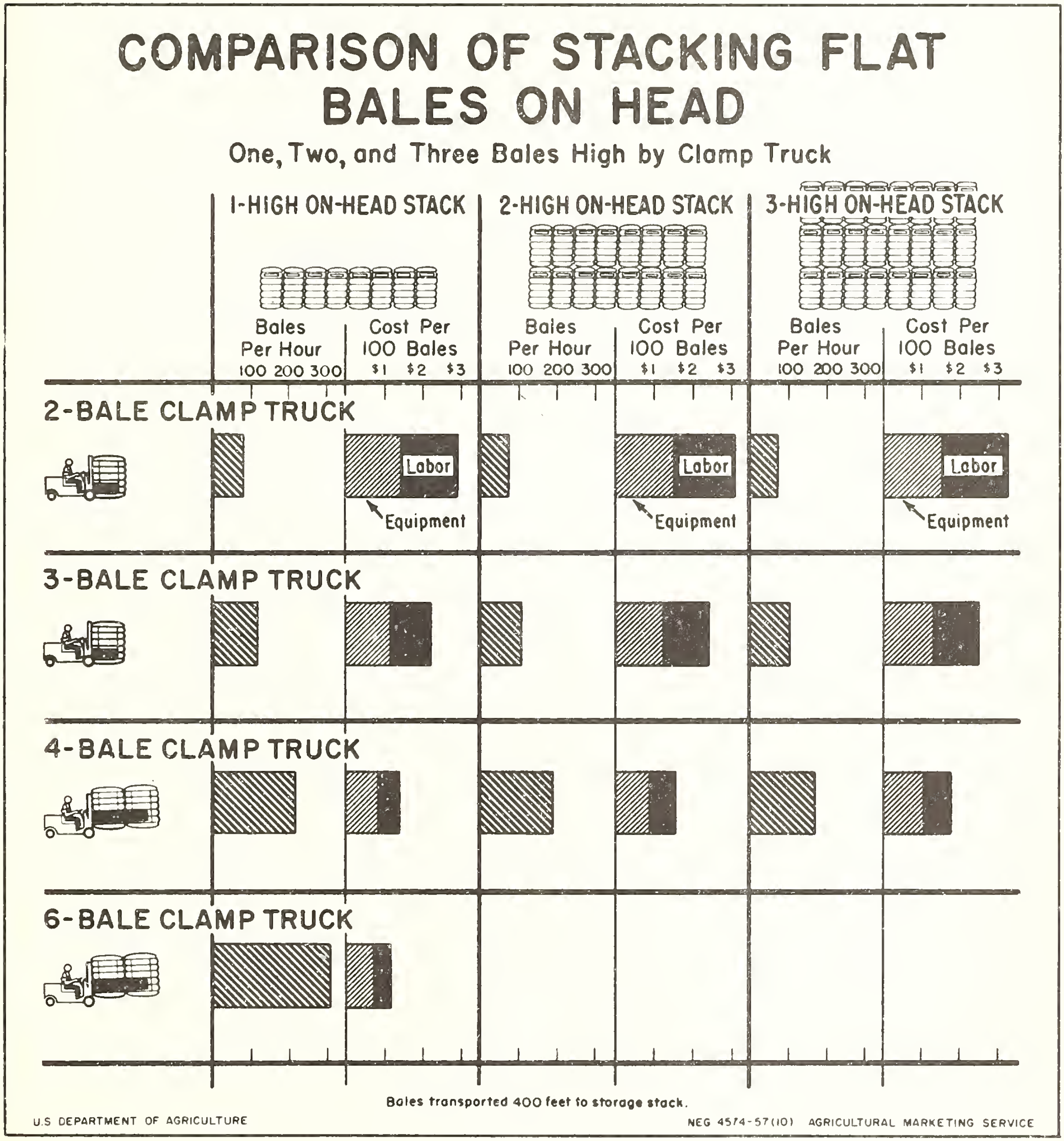

FIGURE 27.

ing, with a cost of $1.80 per 100 bales (fig. 27). The complete job is done at a rate of 170 bales per hour. A 3-bale clamp truck requires 0.97 hour, with a cost of $2.52, and the transporting and storing is done at a rate of about 103 bales per hour. A 2-bale clamp truck requires 1.32 hours, with a cost of $3.23, and stores at about 75 bales per hour. The size of machine used in this operation is usually limited by the strength of the floor, the clearance to the underside of the trusses or beams or sprinkler pipes, and room available for maneuvering.

Storing compressed bales 1 bale high.—In most seaport warehouses, some concentration warehouses, and many warehouses in mill areas, compressed bales are stored on head 1 bale high in solid blocks. Some warehousemen use storage blocks up to 30 bales long and as many bales wide. But when blocks are this large, unbroken by cross aisles, breaking out may become quite expensive. For this reason, many warehousemen use blocks about 10 to 12 bales wide, with cross aisles between blocks, and a divider of wire rope or boards between the 2 middle rows of bales in the block. In a 10-bale block, for example, the divider is placed between the 5th and 6th bales from the cross aisle on either side. Breakout crews then never have to move more than 4 bales to reach either of the 2 center bales.

The costs for storing compressed bales in 1-high blocks are approximately the same as for flat bales, for each of the types of equipment discussed.

A primary advantage of using clamp trucks for stacking is that a clamp truck can pick up a load of bales from a block in the receiving area, transport it to the storage area, and place it in any tier in a stack, all as part of the same operation. Thus there is no need for additional handling into and out of another temporary block near the stack. Also, a warehouseman using a 2- or 3-bale clamp truck can, whenever he wishes, remove the clamps and attach a breakout device. Thus the same machine can be used in several different operations. The warehouseman is thereby able to use his trucks to better advantage, and thus reduce the total size of his warehouse crew and the total amount of equipment required.

BREAKOUT OPERATIONS[20]

In this section, the efficiency and costs of certain methods of breaking out flat and compressed bales are compared.

Breaking bales out of storage stacks is probably the most expensive handling operation in cotton warehousing. At the time a warehouseman makes plans for storing the expected bale receipts during a given season, he usually has to determine the breakout and storage methods to be used. He can do this by comparing what he believes to be the approximate costs of stacking and breaking out for various alternative stacking arrangements that will handle the expected receipts.

Storage Arrangements Commonly in Use

As pointed out in the preceding section ("Storing Operations"), bales are stored in various arrangements. Most such arrangements can be classified as either (1) cordwood storage or (2) on-head storage. Breakout methods likewise will be discussed under the same two general headings.

Cordwood Storage

Flat bales.—Many warehousemen store flat bales in cordwood stacks. Breaking bales out of these stacks is a relatively costly operation, especially if a manual method is used. By the manual method, each bale that obstructs access to the bale to be broken out is first manually lifted and shifted to another position in the stack. Then the desired bale is manually lifted, pulled, pushed, or dragged out of the stack. For example, assume that certain bales are to be broken out of stacks 5 bales high and 2 wide, using 6 men working on the floor and in the stack and 1 hand trucker moving bales to the main aisle as they are broken out. This operation requires 50.26 man-hours of labor at a cost of $50.33 per 100 bales (fig. 28). Moreover, it takes about 7.18 hours to do the job, representing a breakout rate of 14 bales per hour.

It is more efficient to use a boom truck for lifting and shifting bales than to break them out entirely by hand, especially if the boom truck is equipped with a platform on the boom mast, on which the hookman can ride up and down with the boom. Then only the 3 men in the breakout crew—the hookman, truck operator, and hand trucker—are required. With this crew, the breakout operation takes 4.80 hours. Consequently, the job requires 14.40 man-hours of labor, and is done at a cost of $22.37. A 3-man crew using a platform-equipped boom truck can break out 20 bales per hour. To obtain a breakout rate of approximately 100 bales per hour would require 5 such crews.

[20] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

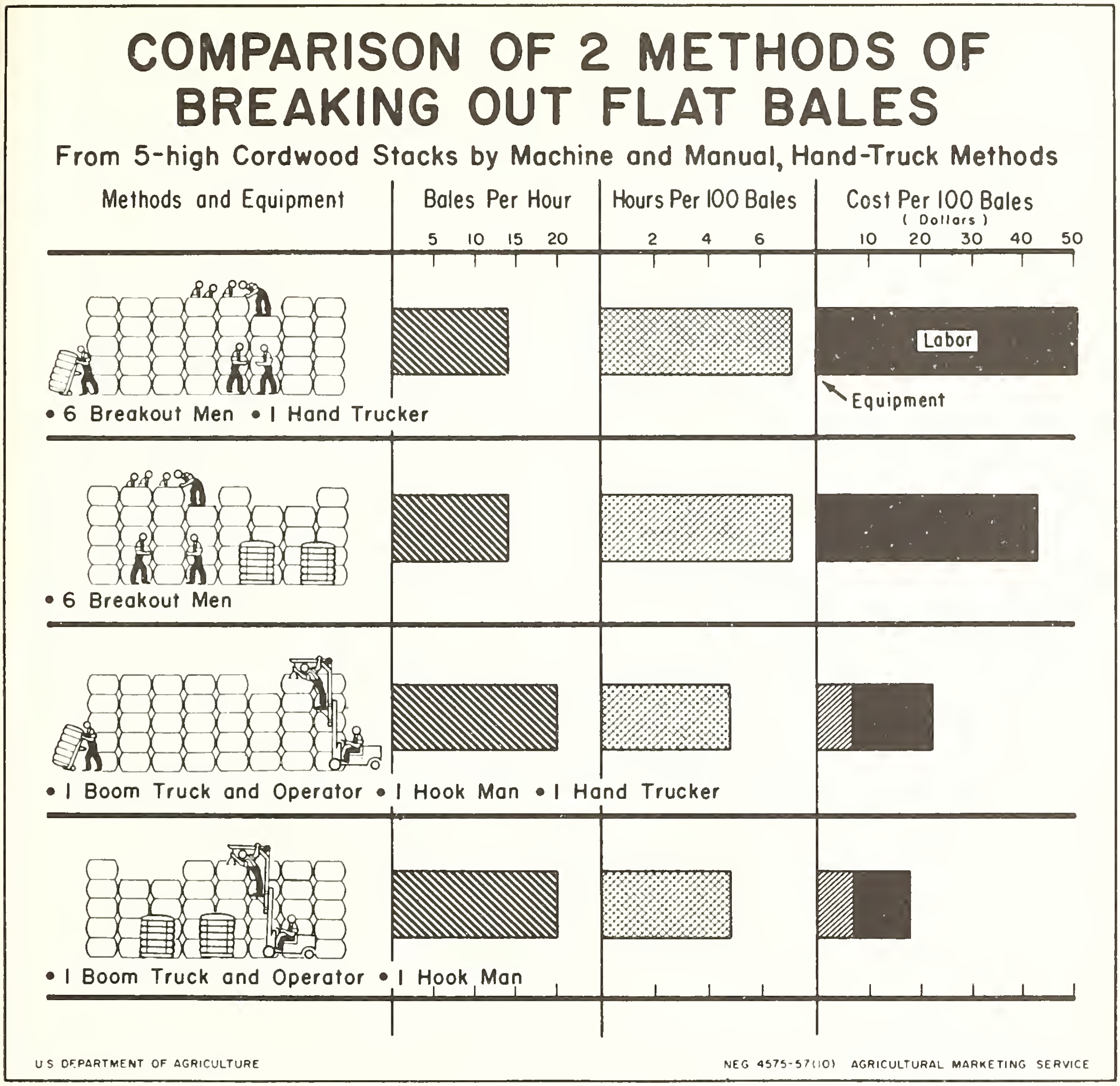

FIGURE 28.

In both of the methods just described, the hand trucker works concurrently with the breakout men. Each bale is moved to the main aisle as soon as it has been removed from the stack. When this procedure is followed, the hand trucker spends much of his time waiting for bales. The actual work time required by a hand trucker to move 100 bales to the aisle is estimated to be 1.91 hours. The difference between 1.91 hours and the breakout time (7.18 hours for the hand crew and 4.79 hours for the manual and boom-truck crew) represents idle time for the hand trucker.

This idle time can be eliminated by moving bales to the main aisle independently of the breakout operation. To do this, the breakout crew, beginning at the wall with each stack and working toward the center aisle, simply leaves each bale in the cross aisle as it is broken out of the stack. At some later convenient time, one or more hand truckers remove the bales and place them in temporary blocks in the main aisle for later pickup by clamp truck or tractor-trailer train. This simple change in procedure reduces the cost of breaking out by the manual method from $50.33 to $43.08, and the cost of

the boom-truck method from $22.37 to $17.51.

A second method of moving bales to the main aisle is to use a clamp truck. For this purpose, the clamp arms should be about 60 to 65 inches long, or long enough to grasp 2 bales in tandem, ball sides together. By this method, 2 bales at a time can be moved by the truck to a temporary block in the main aisle. To facilitate pickup by the truck, bales should be properly positioned as they are broken out. Estimated time for this method is 0.78 hour. Thus bales can be removed from cross aisles and placed in the main aisle in much less time than is required by hand-truck methods, and at the same cost. To move bales at a faster rate by hand truck would require at least 3 truckers (fig. 29).

Compressed bales.—Compressed bales are usually broken out of cordwood stacks by the boom-truck method. The elapsed time is 4.27 hours, and 12.81 man-hours are required, at a cost of $19.90 per 100 bales. The statements previously made concerning the characteristics of manual and of boom-truck methods apply to compressed as well as to flat bales.

On-Head Storage

When stored on head, flat bales are generally placed 1 bale high in solid blocks, or 2 to 3 bales high in row blocks 2 bales wide. Breaking bales out of on-head storage varies widely in speed and cost. Both depend upon the storage and breakout methods used.

Breaking out flat bales stored 1 bale high in solid blocks.—By one method, bales are manually lifted out of the block and rolled or tumbled over the other bales to the aisle. Usually 5 workers stand on top of the bales and pull the desired bale to the top of the block. Then 2 of the workers roll the bale to the main aisle and push it off onto the floor. Another man, working on the floor, guides the bale as it falls to an on-head position. As soon as the 2 men on top of the block release the bale, they rejoin the other 3 to assist in lifting out the

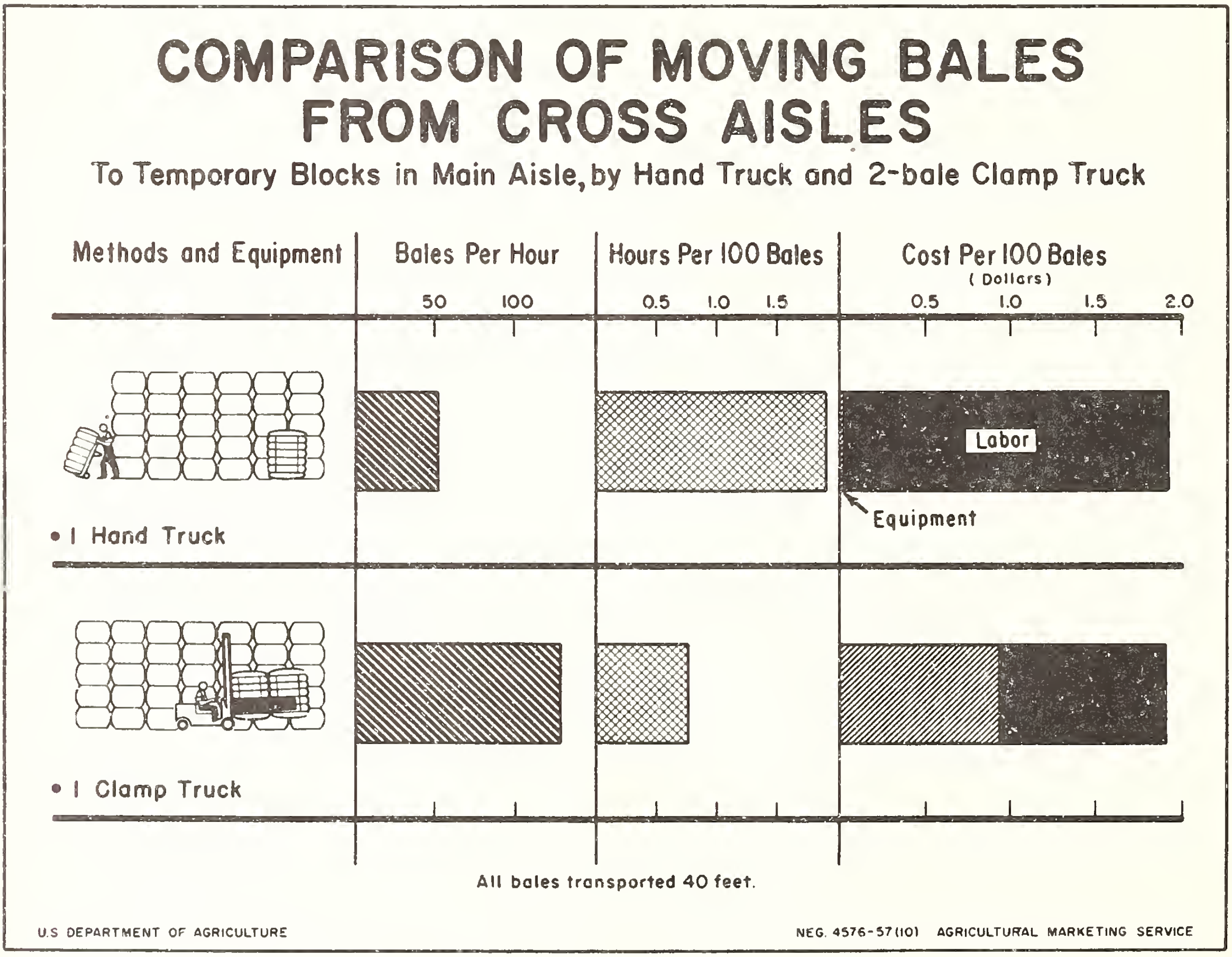

Figure 29.

next bale. At times there is considerable waiting time for 4 crew members while the other 2 members roll a bale to the aisle and return. The man on the floor works only when the bale is dropped to the floor.

In practice, the length and width of storage blocks, and the locations of desired bales within them vary widely. For comparing costs, however, it is assumed that bales are broken out of a block in which each row is 15 bales long from the main aisle to the compartment wall. It is further assumed that each desired bale is found in a different row, and that on the average such bales are moved a distance equal to that for the middle—or 8th—bale in the row.

Under these assumptions, the breakout method described requires 5.64 hours of elapsed time and 39.48 man-hours of labor, with a total cost of $39.48 per 100 bales. The breakout rate is 7 bales per hour (fig. 30).

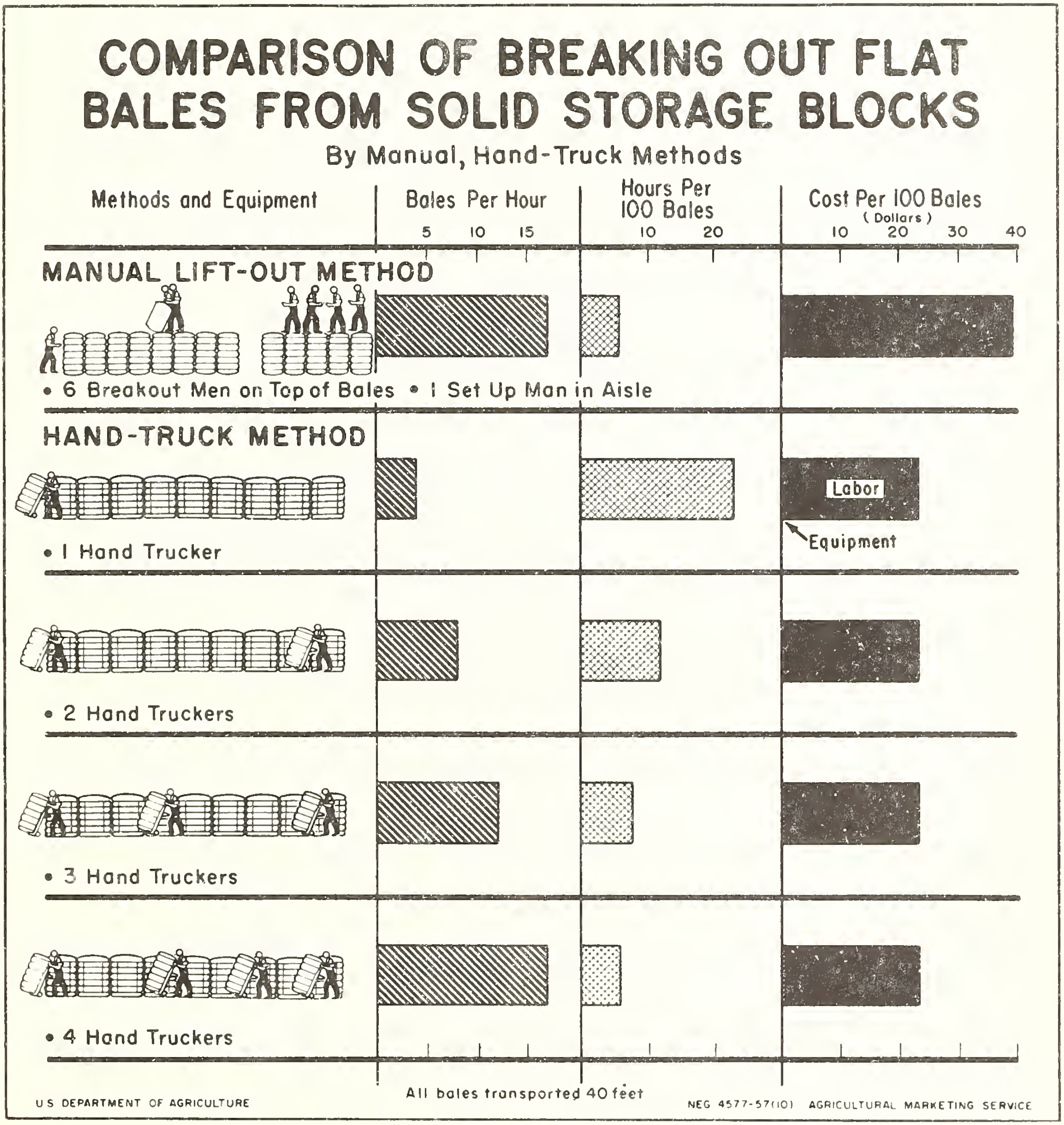

Figure 30.

By a second method, hand truckers remove obstructing bales in a row in the solid block containing the desired bale. This means that, on the average, 7 obstructing bales are removed and then replaced for each bale broken out. After the desired bale has been set in the main aisle, the obstructing bales are returned to the block. Elapsed time for 1 hand trucker to break out 100 bales (which involves also the removal and replacement of 700 obstructing bales) is 23.14 hours. This represents a breakout rate for 1 hand trucker of between 4 and 5 bales per hour.

A warehouseman can use more hand truckers to reduce the elapsed time for this second method. Each trucker then works in a different section of the block or in a different compartment. With each hand trucker working independently, there is no waiting time. Thus the elapsed time would be reduced in proportion to the number of hand truckers used. For example, in using the same 6-man crew as is used in manually lifting bales out of stacks and rolling them to the main aisle, the elapsed time would be 3.85 hours. This compares with 5.64 hours for the lift-out, roll-out method. As a result, the cost of breaking out is reduced from $39.48 to $23.37, a saving of $16.11.

A pulldown man is often used to assist truckers in loading and unloading bales in the block, when a small number of truckers work the same row. This additional man reduces the elapsed time so little that the cost is actually increased. Also, where more than 1 hand trucker works in the same row, crew interference is likely, which increases breakout time and cost. Consequently, such practices are not ordinarily to be recommended.

Warehousemen often place bales in temporary storage in solid blocks by machine, and later remove them in the same way. But this presents a different problem, since such bales usually are broken out in groups rather than as individual bales.

Breaking out flat bales stacked 2 bales high.—Bales often are stored on head in paired or double rows with an aisle on each side, making them accessible for breaking out. In such cases, they most commonly are stacked 2 bales high. Manual or mechanical methods, or a combination of the 2, may be used to break out of such stacks. These methods were discussed in detail in an earlier report (*4*, p. 7).

Breaking out by the manual and hand-truck method usually requires a crew of 3 to 4 workers. A 4-man crew is perhaps the one most commonly used where 1 man works on top of the stack, while 3 men (2 breakout men and 1 hand trucker) work in the cross aisle. The hand trucker's principal duty is to move bales from the cross aisle to the main aisle as they are broken out. Also he may frequently assist the breakout men by using his truck to pry a bale part way out of a stack. To break out by this method takes about 4.25 hours per 100 bales, requiring 17.00 man-hours of labor. The total cost is $17.04, and the breakout rate is 23 bales per hour (fig. 31).

Boom trucks also can be used in breaking out of on-head stacks, with a considerable saving compared with manual and hand-truck methods. But while a boom truck may be satisfactory equipment for breaking out of cordwood storage, it is not the best for use in breaking out of on-head storage. For the latter purpose, a lift truck equipped with a breakout attachment, especially designed for handling bales stored on head, has proved most efficient.

Use of lift trucks equipped with a breakout device reduces crew size, elapsed time, and cost in breaking out. With such equipment, 1 worker and a truck normally can break out 100 bales from stacks 2 bales high in 1.37 hours, at a total labor and equipment cost of $3.29. This represents a breakout rate of about 73 bales per hour, a rate slightly higher than that obtained by 3 manual hand-truck crews of 4 men each (*4*, p. 13).

Compared with the manual and hand-truck method, this machine method reduces crew size from 4 men to 1, and elapsed hours from 4.25 to 1.37. Also, man-hours of labor are reduced from 17.00 to 1.37 (a saving of 15.63) and costs are reduced from $17.04 to $3.29 (a saving of $13.75).

Breaking out flat bales stacked 3 bales high.—Some warehouse facilities have enough head room to permit a warehouseman to use on-head stacks 3 bales high. Where bales are stacked this high, they usually are broken out by machine rather than by hand. One man using a breakout truck requires an estimated 1.51 hours per 100 bales to break out from 3-high stacks at a cost of $3.62, as compared with 1.37 hours from 2-high stacks at a cost of $3.29 per 100 bales. Thus bales normally are broken out at a rate of 65 bales per hour from stacks 3 bales high as compared with 73 bales per hour from stacks 2 bales high (fig. 31).

Breaking out compressed bales stored 1 bale high.—In comparing the cost of breaking out by machine with that by hand truck, it is assumed that compressed bales are stored in blocks 10 bales wide between cross aisles. Also it is assumed that a supporting device (wire, rope, or board) is placed between the 2 middle bales for the entire length of the block, making each half of the block 5 bales deep from the aisle. Another assumption is that the desired bale will be the third bale from either aisle, and that 2 obstructing bales must therefore be re-

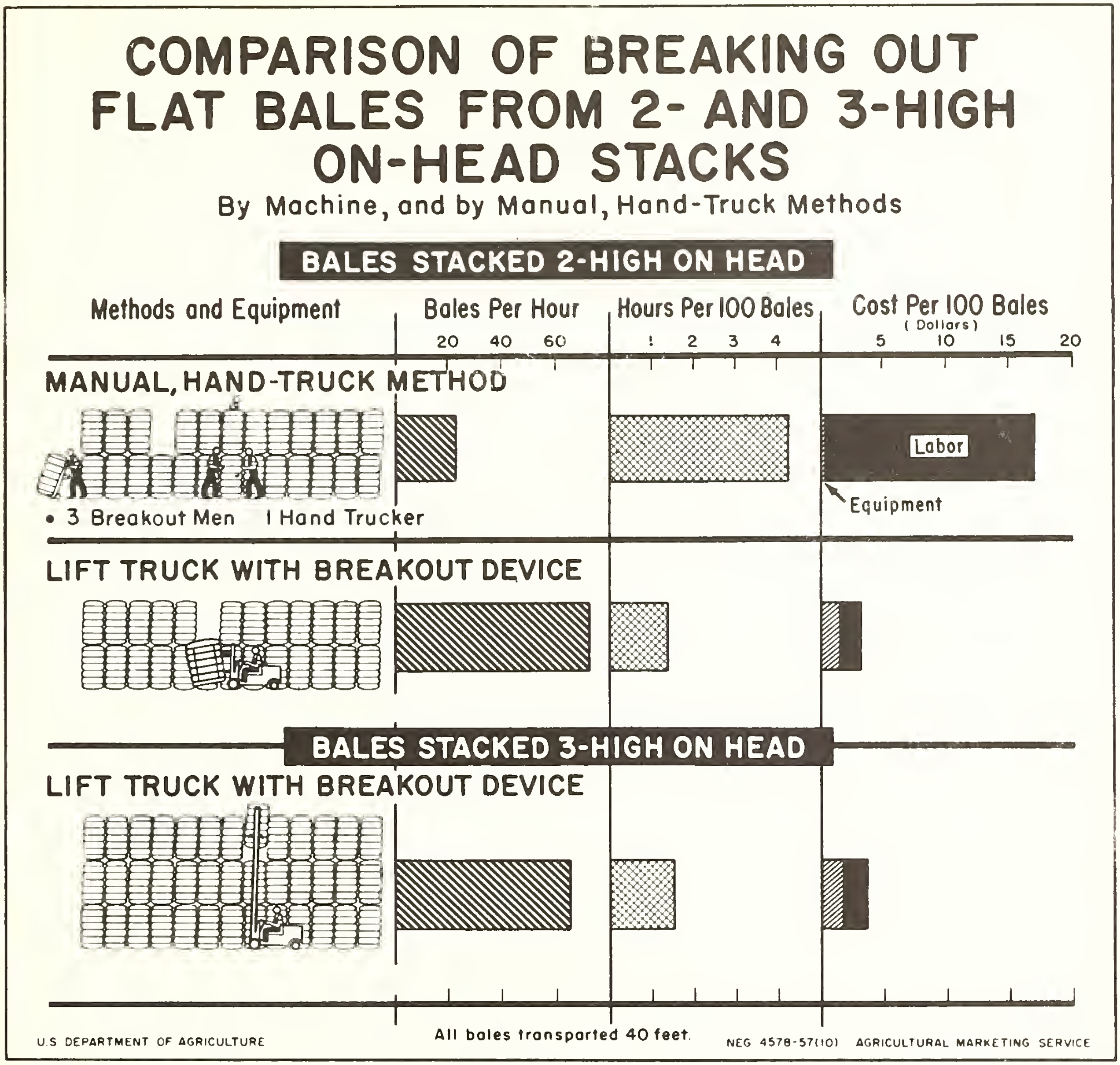

Figure 31.

moved and then stored again for each bale broken out.

Breaking out is most commonly done by (1) hand truck or (2) a lift truck equipped with a breakout attachment. The general procedure is the same for both methods. Obstructing bales are removed to reach the desired bale, this bale is then moved from the cross aisle to the main aisle and set down in a temporary block, and obstructing bales not re-stored at the time of removal are returned to the block from their temporary positions in the cross aisle.

When breaking out is done by hand truck, it takes one trucker 8.83 hours, at a cost of $8.92 per 100 bales. By adding hand truckers, the elapsed time can be proportionately reduced (two truckers take 4.42 hours, etc.), but the cost remains the same. Each trucker works in a different section of the block independently and without a pulldown man. This avoids crew interference and wait time (fig. 32).

When breaking out is done by lift truck, considerable savings over the hand-truck method result (*4*, p. 19). Breaking out then requires

but 1.37 hours for a single truck and operator, with a total cost of $3.29. This equipment breaks out about 73 bales per hour. Thus, for the above type of storage block, one breakout truck can do more work than 6 hand truckers and can do it at about one-sixth to one-seventh of the elapsed time and one-third the cost (fig. 32).

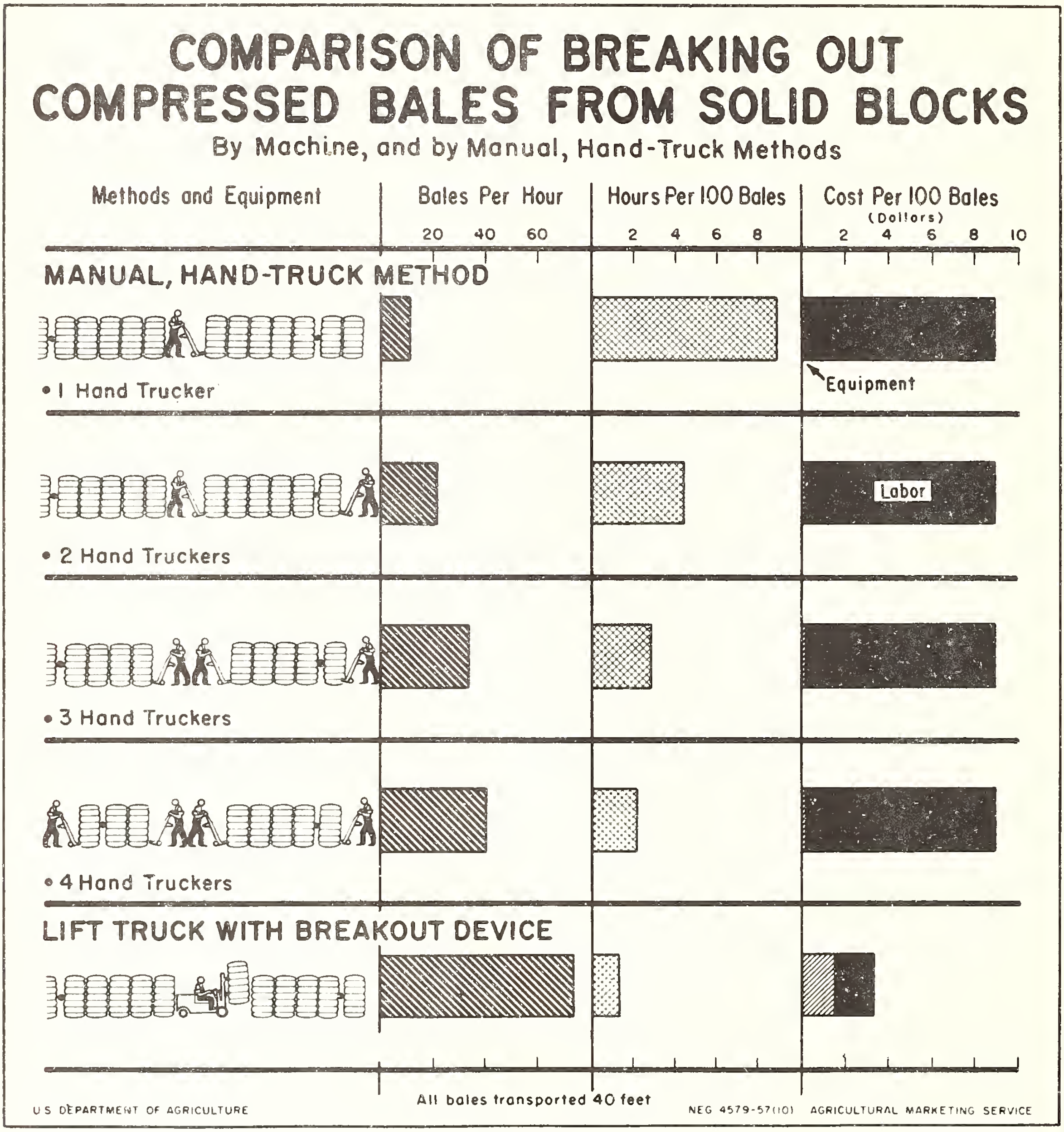

FIGURE 32.

LOADING OPERATIONS[21]

The particular methods and equipment used in loading operations depend in part on whether loading is done from a platform approximately level with the car floor or truck bed, or from ground level. The two main methods used when loading directly from a warehouse platform are (1) the manual and hand-truck method and (2) the clamp-truck method. Other equipment sometimes used includes the fork truck, boom truck, portable elevator, and hoist. Operations involving these latter types of equipment are not discussed in this report as they are not used to any extent.

Where cars and trucks are loaded from ground level, there usually is a court or area that is used for both unloading and loading. Ramps are necessary in loading rail cars from ground level if a clamp truck is to be used. The use of 2- or 3-bale clamp trucks operating over a ramp is an efficient method for loading rail cars. Loading trucks is done with the same equipment, except that (a) ramps are not needed and (b) 4-bale and 6-bale clamp trucks also may be used.

In the methods discussed in this section, the transporting distance from the block to the car or truck is assumed to be 50 feet.

Loading Into Railroad Cars

Railroad cars used in cotton areas usually hold 50 to 60 flat bales, but some warehousemen have loaded as many as 80 bales into a car. Warehousemen usually load from 90 to 125 compressed bales into a car moving to another interior warehouse or to a mill. In shipping to a seaport, they may load from 125 to 140 compressed bales into a car. In the following discussion of loading cars, it is always assumed that a car is loaded with either 50 flat bales or 100 compressed bales.

Loading Cars From Platform at the Car Floor Level

Most warehouses where bales are loaded into cars have platforms approximately level with the car floor. Most warehousemen use 2- or 3-bale clamp trucks for loading. Only 2-bale clamp trucks can be used to load flat bales, but both 2- and 3-bale trucks can be used to load compressed bales.

Loading by manual and hand-truck method.—This is the least efficient method for loading bales into cars where platforms are at car-floor level. In stacking flat bales 2 high on head within the car, hand truckers set bales down in the first tier and another crew of about 6 men lift bales to the second tier. Since the 6 loaders work mostly at lifting bales to the second tier, they are idle about half the time. This idle time is inherent in the operation and is part of the cost of loading. Loading a car, with 2 hand truckers and a 6-man loading crew, requires 1.16 hours of elapsed time and 9.28 man-hours of labor per 100 bales, at a cost of $9.30 for bales and equipment (fig. 33).

The method used to load compressed bales into cars is similar to that used for flat bales. Loading a car, with a 7-man loading crew in the car and 2 hand truckers bringing bales to the car, requires 1.02 hours of elapsed time and 9.18 man-hours of labor. An extra lifter is used on top of the first tier to assist in securing bales in the second tier. This involves a labor and equipment cost of $9.20. As in loading flat bales the 7 loaders are idle about half the time, and this idle time is inherent in the operation.

Loading by clamp truck.—Using clamp trucks for loading railroad cars saves much time and money over the manual and hand-truck method. In most cases, 2-bale clamp trucks are used, and the time for loading 100 flat bales (2 carloads) is 0.75 hour at a cost of $1.84. Compared with the 8-man manual and hand-truck method described for loading flat bales, the clamp-truck method requires 0.41 fewer hours elapsed time and reduces costs by $7.46 (fig. 33).

When a clamp truck is used to load compressed bales, there is a reduction of 8 men compared with the manual and hand-truck method. A 2-bale clamp truck requires only 0.77 hour, a saving of 0.25 hour, and man-hours are reduced from 9.18 to 0.77. As a net result, the labor and equipment cost is reduced from $9.20 to $1.89. A 3-bale clamp truck further reduces the time for loading compressed bales, as it requires but 0.66 hour; and the cost is reduced from $1.89 to $1.72.

Loading Cars From Ground Level

Some warehouses do not have platforms at the car-floor level, and bales are loaded into cars from ground level. This operation, if performed without ramps, is in most cases extremely inefficient. Some warehousemen, however, are able to use 2-bale clamp trucks and movable ramps for loading operations. This makes loading from ground level about as efficient as loading from a platform. Magnesium-aluminum ramps are the easiest to handle.

Loading by manual lift-up method.—Using the manual lift-up method of loading flat bales into a car from ground level is perhaps the

[21] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

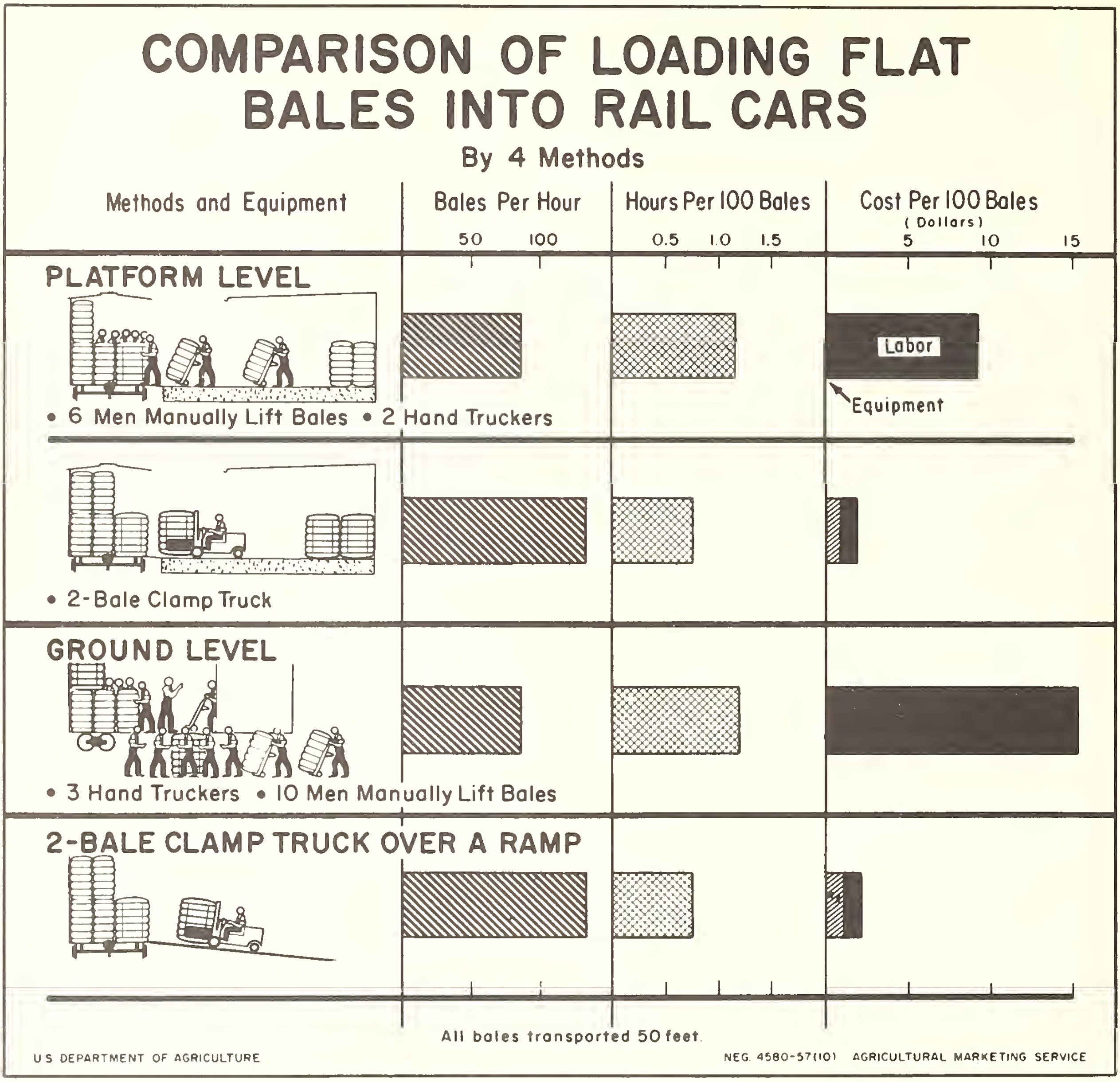

FIGURE 33.

most inefficient way to do this operation. Thirteen men, 7 on the ground and 6 in the car, usually are required. On the ground 2 hand truckers move bales about 50 feet from a temporary block to a point below the car door. A crew of 5 lifters on the ground, assisted by 2 men in the car, manually lift the bales into the car. Inside the car, 1 hand trucker sets bales down in the first tier and also trucks bales to other points inside the car where they can be manually lifted to the top tier. He and the 5 lifters inside the car lift the bales to the top tier and the lifters position the bales in the tier. This method requires an elapsed time of 1.18 hours and 15.34 man-hours of labor per 100 bales. The total direct labor and equipment cost is $15.37 (fig. 33). About 7 of the total man-hours represent idle time inherent in the operation.

A few studies were made in which an electric portable elevator on the ground outside the car door was used to lift bales into the car. Bales were moved to the portable elevator from a temporary block by 2 hand truckers. The elevator was operated by a third man, and 2 men inside the car pulled bales off the elevator platform and moved them into place. Bales were placed in the lower tier by hand truck and in

the second tier by being hand-rolled into position. The studies, although too few to justify firm conclusions as to time requirements, indicated that a 5-man crew working in this manner can load 100 bales in about 1 hour. Even though the labor was not efficiently used, the total labor input, in both man-hours and cost, was about two-thirds less than that for the manual lift-up method.

Loading by clamp truck and portable ramp.—The deficiencies of manual methods can be largely overcome by using portable ramps and 2-bale clamp trucks for loading cars from ground level. Ramps have to be portable, for movement from one car to another. Using a portable magnesium-aluminum ramp and a 2-bale clamp truck to load flat bales into a car requires an elapsed time of about 0.75 hour, with a cost, including the ramp, of $2.06 (fig. 33).[22]

One man, a clamp truck, and a portable ramp can replace 13 men and 3 hand trucks in loading flat bales into cars. Elapsed time is reduced 0.43 hour, or more than 35 percent, and man-hours are reduced 14.59 hours, or more than 95 percent. Savings in cost amount to $13.31, or over 85 percent. Comparable reductions also are realized in loading compressed bales. In fact, some further reduction in time and cost can be effected by using a 3-bale clamp truck instead of a 2-bale truck. It should again be pointed out, however, that from 7 to 8 minutes often is required to take down, move to the next car, and set up available models of portable ramps. This job represents a cost in addition to the direct loading cost shown for operations in which such ramps are used.

Loading Onto Road Trucks

One of the most efficient methods of loading bales onto road trucks is the use of clamp trucks working from ground level. Many warehouses, however, have only truckbed-level platforms, and they generally lack space for ground-level operations. At such warehouses, loading often is done by manual and hand-truck methods. A diminishing number of small warehouses still have such equipment as fork trucks, portable elevators, rockers, and hoists for loading trucks. However, this type of equipment is less efficient than clamp trucks and is gradually becoming obsolete. Methods using such equipment are not discussed in this report.

Loading From Truckbed-Level Platforms

There are 2 methods generally used to load flat bales onto road trucks from truckbed-level platforms. Hand truckers and manual lifters are used in 1 method and a clamp truck and manual helpers in the other.

Loading by manual and hand-truck methods.—Hand truckers move the bales over the tailgate onto the road truck and stand them on head on the truckbed. When the truckbed is filled, most of the truckers help to lift other bales to the top tier. In an 8-man crew, usually 1 man continues to hand truck bales to the tailgate, while the 5 men on the platform or truckbed and the 2 men on top of the first tier lift each bale onto the top of the tier. The two men on top of the tier then move the bales into place. An 8-man crew requires 6.64 man-hours, with a labor and equipment cost of $6.66, and the elapsed time is 0.83 hour (fig. 34).

Since more hand truckers are used than are really needed to set out bales on the truckbed, much idle time results. Also, the 5 men lifting bales often are idle while the 2 men on top are moving bales into place. The hand trucker often has to wait until the loaders are ready to lift the next bale. All of this idle time is inherent in the method and is not easily corrected by changing the crew organization.

Loading by manual and clamp-truck methods.—Ordinarily, with this method, a 2-bale clamp truck and 2 manual helpers are used. The clamp truck, working from the warehouse platform, places bales on the truckbed near the tailgate. One hand trucker then moves the bales onto the bed of the truck, and he is assisted by a setup man in jockeying the bales into position. When the truckbed is filled, the hand trucker and setup man climb on top of the tier to assume new duties. The clamp truck now places bales on top of the first tier, and the 2 men roll them into place. This 3-man crew requires 0.75 hour of elapsed time (fig. 34), a labor input of 2.25 man-hours, and a labor and equipment cost of $3.35. This method also has some inherent idle time (that of the clamp truck operator waiting on the 2 loaders) which cannot be easily reduced.

As in unloading, the most efficient way to load a truck from a warehouse platform is to move a clamp truck directly onto the truckbed with its load. This operation has the advantage that only 1 man and a clamp truck are needed for the operation. But, as pointed out before, many operators of road trucks have been reluctant to permit clamp trucks aboard their vehicles. When this method can be used, however, both time and costs can be reduced. Such reductions include advantages to both the warehouseman and the truck owner.

Loading From Ground Level

Several methods are used to load flat bales onto road trucks from ground level. The 2

[22] The setting up and moving of the ramp should be added to the above elapsed time and dollar cost.

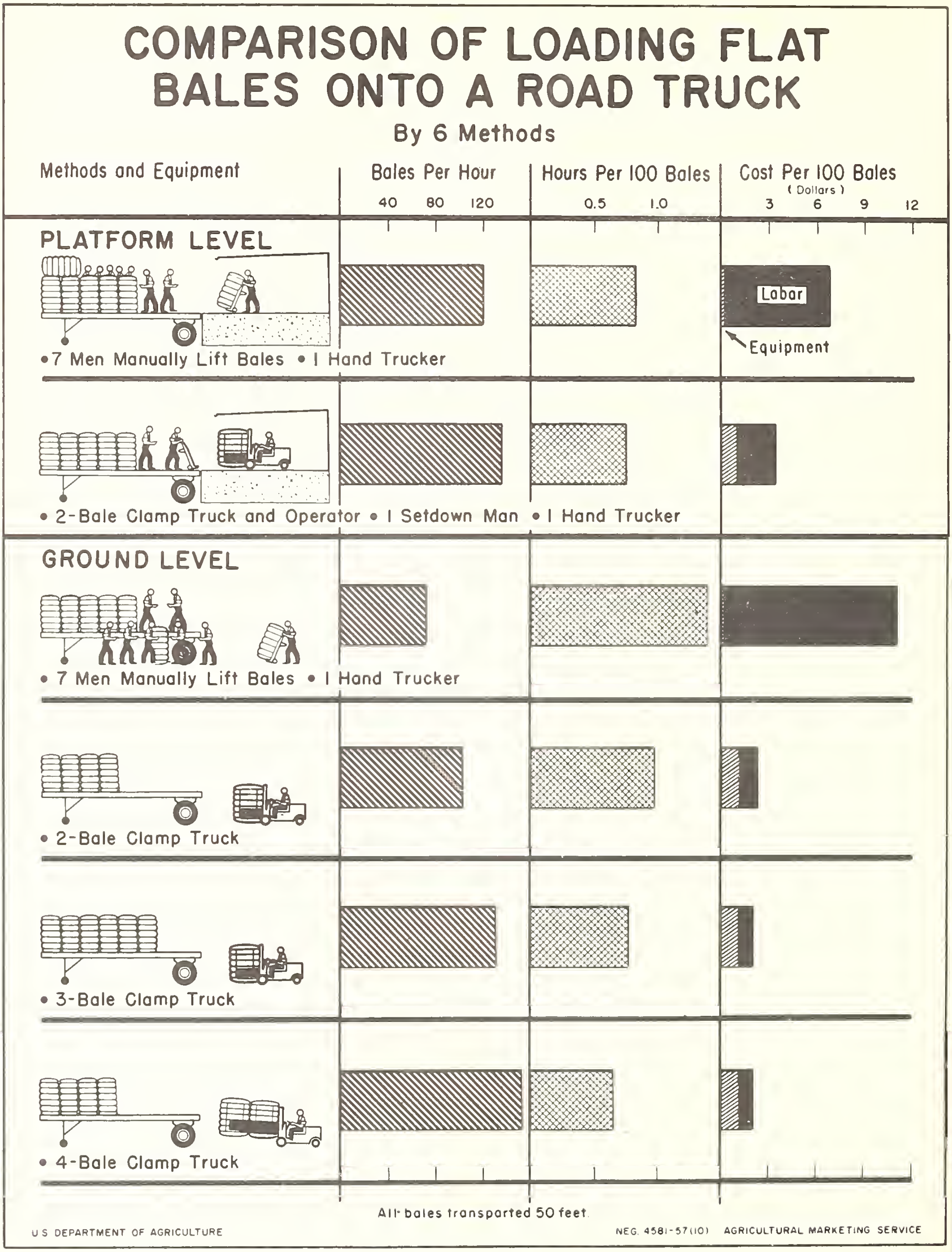
COMPARISON OF LOADING FLAT BALES ONTO A ROAD TRUCK
By 6 Methods
Methods and Equipment
Bales Per Hour
40 80 120
Hours Per 100 Bales
0.5 1.0
Cost Per 100 Bales
(Dollars)
3 6 9 12
PLATFORM LEVEL
Labor
Equipment
• 7 Men Manually Lift Bales • 1 Hand Trucker
• 2-Bale Clamp Truck and Operator • 1 Setdown Man • 1 Hand Trucker
GROUND LEVEL
• 7 Men Manually Lift Bales • 1 Hand Trucker
• 2-Bale Clamp Truck
• 3-Bale Clamp Truck
• 4-Bale Clamp Truck
All bales transported 50 feet
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FIGURE 34.

methods most generally used are: (1) Manual lift-up method; and (2) clamp-truck method.

Manual lift-up method.—This method is still being used in some country warehouses. It is one of the least efficient ways of loading bales. Bales are usually positioned 1 high on head on the truckbed. This is done as follows: 1 hand trucker moves bales to the side of the road truck; then 5 men on the ground and 2 men on the truck lift the bales onto the truck. The 2 men then jockey the bales into place on the truck. This 8-man crew requires 1.38 hours of elapsed time and 11.04 man-hours of labor at a loading cost of $11.05 for labor and equipment (fig. 34).

There also is considerable inherent idle time in this method. The hand trucker at times has to wait on the loading crew, and at other times the loading crew may have to wait on him. Also, the 5 loaders sometimes have to wait on the 2 men working on the truckbed, and sometimes these 2 men have to wait on the 5 loaders.

Loading by clamp truck.—A clamp truck is the most efficient piece of equipment used for loading bales onto road trucks from ground level. When 1 clamp truck is used, the loader should alternate between the 2 sides of the truckbed. In many cases, 2 clamp trucks are used, one on each side of the road truck.

The elapsed time and the cost for loading by a single truck depend upon the size of clamp truck used. A 2-bale clamp truck, for example, requires 0.97 hour, with a cost of $2.37. A 3-bale truck takes 0.77 hour, at a cost of $2.00, and a 4-bale truck takes but 0.65 hour, at a cost of $1.98 (fig. 34).

The loading of compressed bales onto road trucks from ground level by clamp truck sometimes presents a different problem. The average truckbed holds 4 compressed bales set on head between the 2 sides. The ordinary 2- or 3-bale clamp truck, because of the short reach of its clamps, usually cannot set bales back as far as necessary on the bed of the road truck. Skill and time are needed to position bales in their proper place. In some instances, a helper is used aboard the truck to shift bales by hand. However, 4-bale clamp trucks, with longer clamps, can set bales back as far as necessary from either side of the truck.

The usual method of loading compressed bales from ground level with a 2- or 3-bale clamp truck is first to place bales onto the truck from the sides, then to move them into place by pushing them directly with the tips of the clamps or by pushing them with the next bales that are loaded. When a 2-bale clamp truck is used, 1.26 hours are required to complete the loading. The labor and equipment cost is $3.08. A 3-bale truck requires 0.97 hour, with a cost of $2.52. When a 4-bale clamp truck is used, it is relatively easy to set bales in their final positions on the truck. The clamp truck alternates between the 2 sides of the truck, placing a 4-bale load first on 1 side and then on the other. By this method, bales can be loaded onto a road truck in 0.64 hour, with a labor and equipment cost of $1.95.

In some instances a 6-bale clamp truck may be successfully used. Such an operation, however, usually requires a lift truck driver of considerably greater than average skill. Otherwise, much time may be lost in ineffective maneuvers to pick up or to place bales.

HANDLING OPERATIONS CONNECTED WITH COMPRESSION[23]

The actual compressing of bales was not included in this study. However, several handling operations are involved in bringing bales to the compress and removing them after compression. These operations, which deal mainly with the compression of flat bales to standard or high density, are discussed in this section.

Transporting Bales to the Dinky Press[24]

Two handling operations are performed in bringing bales to the dinky press. Bales are usually transported from a segregating block in or near the press room to a small temporary block near the press, and then from this temporary block to the press.

Transporting Methods

There are several methods of transporting bales to the dinky press. Among the better methods are:

First method.—One hand trucker moves bales 15 feet from a temporary block to the dinky press, and a pulldown man at the block assists

[23] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

[24] Some of the small compress plants do not use dinky presses. Compresses of this type usually have an area back of the press called a "bull ring" where flat bales are positioned on the ball side. Usually 1 man cuts the bands or breaks the buckles; another helps load the bale on a hand truck; and a third man removes the bands. Methods of this type are used so rarely that they will not be discussed further.

in loading each bale onto the hand truck. The bale is placed on the truck on the ball side with buckles facing in the right direction for placement in the dinky. The hand trucker unloads the bale directly into the dinky, and the dinky operators need not help position the bale in the press. A 2-bale clamp truck is used to move bales from the segregating block to the temporary block, usually a distance of 160 feet. The elapsed times are 0.98 hour to hand truck bales from the temporary block to the dinky, and 0.70 hour to transport bales by clamp truck from the segregated block to the temporary block. Thus, the total movement is completed in 0.98 hour per 100 bales.

Second method.—This method eliminates the pulldown man at the block. The hand trucker, without assistance, loads a bale on head onto his truck from the block. He then moves the bale to the dinky and sets the truck down beside and parallel to it. The hand trucker and one of the dinky operators then roll the bale off the truck into the press. This operator has other duties at the dinky, and so does not represent an additional cost; also, he is always free to assist in positioning a bale in the dinky. As in the first method, a 2-bale clamp truck is used to move bales from the segregating block to the temporary block. The time requirements are the same for both methods.

Third method.—A clamp truck, carrying 1 bale at a time from the temporary block, is used to feed bales directly into the dinky. The bale is pulled over onto a flat side, then picked up and held, buckles up and to the front, with the clamps pressed against the ends of the bale. Only one clamp truck is needed when the temporary block is 20 feet from the dinky. When this distance is over 20 feet, but less than 200 feet, a second clamp truck is needed. However, a second clamp truck is best used for transporting bales 2 at a time from the segregating block to a temporary block about 15 feet from the dinky. With such a block the flow of bales to the dinky can be quickly adjusted to conform to minor fluctuations in the pressing rate. The elapsed time for 1 clamp truck to feed the dinky from 15 feet is 0.78 hour. As before, bales are moved from the segregating block to the temporary block in 0.70 hour.

Fourth method.—This fourth method uses an automatic dinky-press feeder, consisting of a loading chute and a conveyor leading from the chute to the dinky, which can hold up to 6 bales. In effect, the feeder provides a small temporary or floating block where as many as 3 bales can be held in the loading chute, and 3 more on the conveyor belt. When a 3-bale clamp truck equipped with a rotating clamp is used, the chute of the automatic machine can be kept loaded directly from the segregating block. Only 1 such clamp truck is needed on distances up to 200 feet. The clamp truck picks up 3 bales from the segregated block and moves them to the automatic dinky feeder. While en route to the feeder, the bales are turned by the rotating clamp from on-head to on-side position. The bales are placed 3 high, on-side, buckles up, in the loading chute of the feeder. One of the dinky operators controls a switch for moving the bales from the feeder chute to the dinky. The required elapsed time for moving bales to the dinky by this method from a block 160 feet from the feeder is 0.77 hour.

All 4 of the methods described use clamp trucks to move bales from the original segregating block to the vicinity of the dinky press. Hand trucks for such transporting are too expensive for consideration as alternative methods. One such method was discussed in an earlier report (*1*, p. 3).

Transporting Costs per 100 Bales When the Pressing Rate Is 100 Bales per Hour

In computing costs for handling operations connected with compression, it is essential that one consider the pressing rate. It is usually the pressing time, rather than the transporting time, that determines how much time is spent on the job. Pressing time may also determine the crew size required, or the method that should be followed. If, for example, 1 hand trucker is unable to feed bales to the dinky fast enough to keep up with the main press, a second hand trucker will be added. On the other hand, any transporting crew will have frequent periods of wait time if they can handle bales faster than the press. Crew members draw pay for the time spent waiting as well as for the time spent working, and this wait time becomes a part of the total cost.

The crew sizes in each of the 4 methods, discussed further below, were determined as the minimum necessary to keep pace with a pressing rate of 100 bales per hour. With each method bales can be delivered to the dinky at the rate of 100 or more per hour. But since the elapsed time for compression is 1 hour, the effective elapsed time for transporting bales to the dinky, by any of these methods, will also be 1 hour. Therefore, where the pressing rate is 100 bales per hour, the labor and equipment requirements and costs for the 4 methods are as follows:

First method:

Requires a 3-man crew, 1 hand truck, and one 2-bale clamp truck

Pulldown man works 0.46 hour, waits 0.54 hour

Hand trucker works 0.98 hour, waits 0.02 hour

Clamp truck operator works 0.70 hour, waits 0.30 hour
Total labor requirements: 3 man-hours
Total labor and equipment cost: $4.46

Second method:
Requires a 2-man crew, 1 hand truck, and one 2-bale clamp truck
Hand trucker works 0.98 hour, waits 0.02 hour
Clamp-truck operator works 0.70 hour, waits 0.30 hour
Total labor requirements: 2 man-hours
Total labor and equipment cost: $3.46

Third method:
Requires a 2-man crew, and two 2-bale clamp trucks
Clamp-truck operator (feeding dinky) works 0.78 hour, waits 0.22 hour
Clamp-truck operator (delivering to temporary block) works 0.70 hour, waits 0.30 hour
Total labor requirements: 2 man-hours
Total labor and equipment cost: $4.90

Fourth method:
Requires a 1-man crew, one 3-bale clamp truck (with rotating clamps), and 1 automatic feeder
Clamp-truck operator works 0.77 hour, waits 0.23 hour
Total labor requirements: 1 man-hour
Total labor and equipment cost: $3.60

Thus, the second and fourth methods are the least expensive, with a pressing rate of 100 bales per hour. All 4 methods also can be used without change for pressing rates under 100 bales per hour. Where the pressing rate normally exceeds 100 bales per hour, however, it may be necessary to add workers and equipment (fig. 35).

Transporting Costs per 100 Bales When the Pressing Rate Is 110 Bales per Hour

The following revisions would be necessary if the 4 methods described were to be adapted for use with a pressing rate of 110 bales per hour.

First method.—An additional hand trucker (or a total of 4 workers) would be required. The net result would be that the total labor and equipment cost would be increased to $4.97.

Second method.—An additional hand trucker (or a total of 3 workers) would be required. Total labor and equipment cost would be increased to $4.06.

Third method.—No change would be necessary in crew size or number of units of equipment. The clamp truck requires 0.86 hour to move the bales to the dinky press and has 1 hour in which to do it. Total labor and equipment costs, at this higher pressing rate, would be decreased to $4.45. This decrease in cost results from the reduced elapsed time that accompanies any increase in the pressing rate.

Fourth method.—No change is required. The clamp truck needs only 0.86 hour to move the bales to the feeder and has 1 hour in which to do it. Total labor and equipment costs would be decreased to $3.28.

Thus, for a pressing rate of 110 bales an hour, the fourth method at $3.28 is least costly. Its cost in this case is about 20 percent lower than that of the second method which, with a cost of $4.06, is the next cheapest (fig. 35).

Transporting Costs per 100 Bales When the Pressing Rate Exceeds 110 Bales per Hour

Most compress operators are satisfied if they are able consistently to press between 100 and 110 bales an hour. They would be most happy, of course, to obtain rates exceeding 110 bales per hour, but few are able to do this except for short periods. The crew sizes indicated above for 110 bales per hour should be able, except for the third method, to take care of pressing rates up to 125 bales an hour. At this pressing rate of 125 bales per hour, a single clamp truck bringing bales from the segregating block is just able to keep up with the main press. For a higher rate, whichever method is used, an additional clamp truck would be needed. However, the third method, which uses a clamp truck to feed the dinky, ordinarily requires a second clamp truck for this purpose if the pressing rate exceeds 125 bales per hour. Also, for rates above 140 bales an hour, a second clamp truck usually is needed to transport bales from the segregating block to the temporary block near the dinky.

The costs for the 4 methods for a pressing rate of 120 bales per hour would be as follows: First method, $4.55; second, $3.75; third, $4.08; fourth, $3. Again, the method using an automatic dinky feeder is the cheapest. A graphic comparison of the costs of transporting bales to the dinky by the methods discussed is shown in figure 35.

Removing Bales From the Main Press

As a part of the press operation, the press crew usually removes compressed bales from the platen of the main press onto the door plate of the press. At this point, the bales ordinarily are picked up by a hoist on a steam-operated jib crane. The bale is held by hooks suspended from the crane. After picking up a compressed bale, the hoist man usually releases it either (1) onto a hand truck, or (2) against a buck bar or post, or (3) onto a tractor-trailer train. Most commonly, bales are moved to a buck bar or post rather than loaded onto a tractor-trailer train. There they are placed in

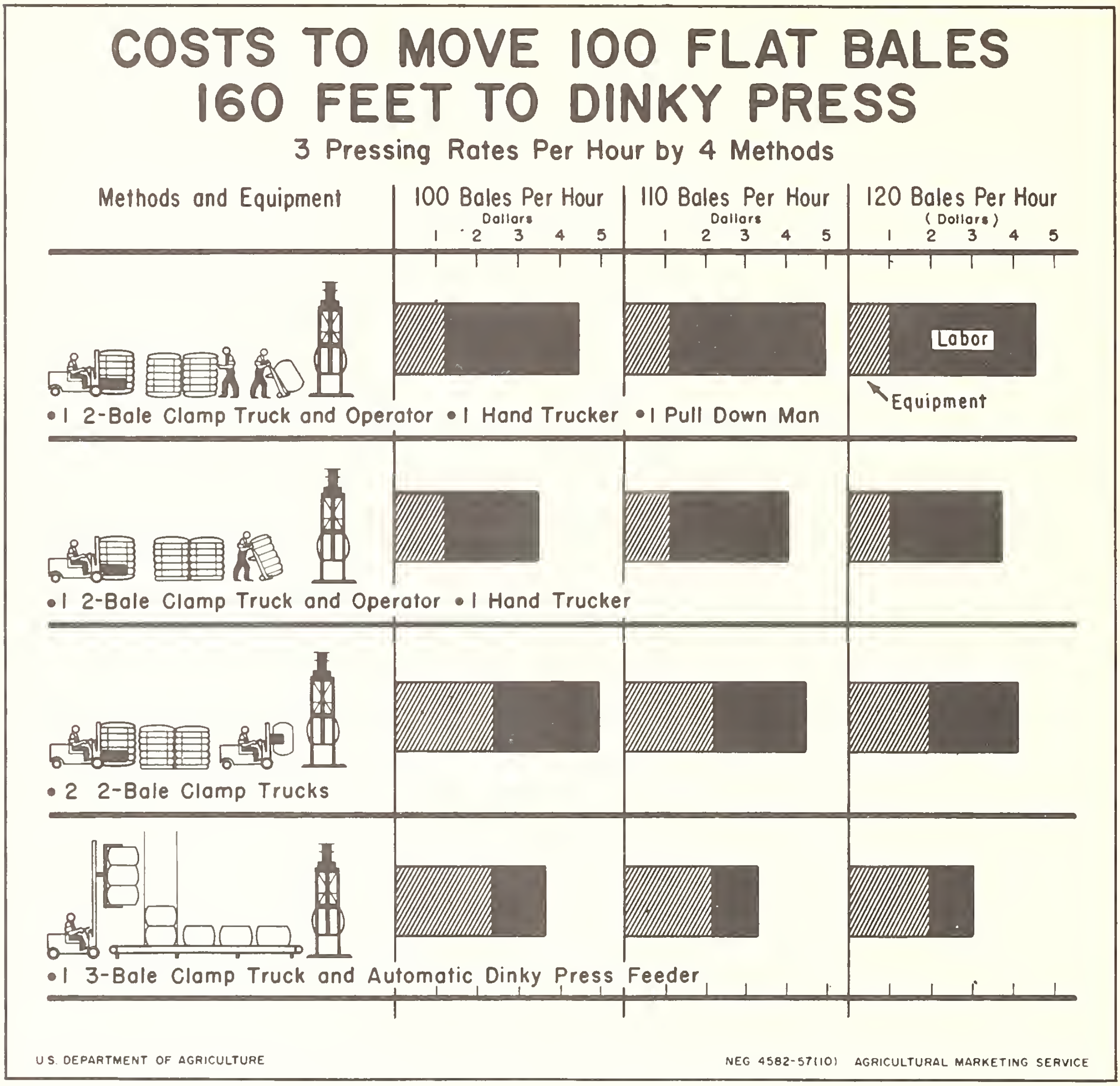

FIGURE 35.

an on-head position for pickup by a clamp truck. This section deals only with the short movements of bales from the point at which they are picked up by the jib crane, on or near the door plate, to the buck bar, trailer train, or other terminal area. Distances for these movements usually are from 10 to 20 feet.

In general, 2 methods are used for moving bales to a buck bar or post. The first method uses both the jib crane and hand trucks; the second method uses the jib crane alone. If the buck bar is located beyond the reach of the jib or boom, the first method is used. Bales may be carried about 10 feet by the jib crane, and an additional 10 feet or so by hand truck. If the buck bar is located within the radius of the jib, hand trucks are not needed *(5, pp. 27-30)*.

The first method generally requires only 1 hand trucker, but many compressmen use 2 truckers. On the basis of 1 hoist man and 1 hand trucker, costs for this method range from $2.03 with a pressing rate of 100 bales an hour, to $1.68 for 120 bales per hour.

Where the second method can be used, only 1 worker, the jib operator, is required. Bales are moved as follows: (1) The hoist man attaches hooks to and picks up each bale at the

press; (2) he then pushes or pulls the bale, which swings from the jib, until it reaches the buck bar; (3) he lowers the bale into place against the buck bar and disengages the hooks; and (4) he returns to the press to pick up the next bale and repeat the cycle. By this method, 1 worker is able to move bales as fast as 2 to 3 workers by the first method. For a pressing rate of 100 bales per hour, labor costs for this method are $1.00; for 120 bales per hour, $0.83.

When bales are loaded onto a trailer train, the trailers should be brought within reach of the jib. The hoist man is then able to load a bale onto a trailer in about the same time as he is able to unload it against a buck bar. Some compressmen use a helper to assist the hoist man in loading trailers. But there is little evidence to show that such a helper is needed, except when the pressing rate is extremely high or when it is not possible to bring trailers within reach of the jib crane. In the latter case, 2 helpers, 1 a hand trucker, sometimes are needed. If only the hoist man is used, costs are the same for moving bales to a train as for moving them to a buck bar, $1.00 and $0.83, for 100 and 120 bales per hour, respectively.

MISCELLANEOUS WAREHOUSE OPERATIONS

Each of the eight preceding sections has dealt with a basic handling operation in the warehousing of cotton. There are several other operations which either involve or are related to bale handling. Among these are such operations as (1) relocating tags, (2) spotting, (3) reweighing, and (4) resampling. It was not the purpose of this research to obtain detailed time and cost data for such operations. The brief discussions that follow, therefore, are of a general nature only.

Tagging

Warehouse tags can be initially attached to bales at any one of several stations in the receiving cycle. As noted earlier, they are usually attached just before, during, or shortly after weighing. Regardless of when the tag is physically tied to the bale, the tag number is identified with the bale for weighing, sampling, and all subsequent operations.

Changing the Tag Position

The most important requirement in locating the tag is that the tag number always be visible. For this reason, the tag is usually attached to a corner or to some point along the edge at the top of the bale. But when tags are so located, it sometimes is hard to identify bales that have been placed in the top tiers of high stacks. To avoid this difficulty, many warehousemen, as bales are being stacked in an upper tier, remove the tags from the top edge of bales and reattach them to the bottom edge. This shifting of tags is usually done by one worker as the clamp truck doing the stacking brings up the bales. He stands close to the stacking point and removes and re-ties the tags as necessary. He is idle while the clamp truck moves to the temporary block, returns with a load of bales, and places the bales in the stack. Also, while tags are being shifted, the lift truck and operator are delayed and the entire stacking operation is slowed. This inefficient retagging procedure substantially increases stacking costs.

A warehouseman can usually avoid much of the added cost of changing tag positions if he does one of the following:

(1) Does not relocate tags, but makes it easier to identify bales in stacks by insuring proper initial positioning of the tag, by using large type for the tag number, and by using improved lighting in stacking areas.

(2) Changes tags in the temporary block before the clamp truck arrives to pick up the load. This procedure eliminates the wait time for the truck and operator.

(3) Pre-positions bales before stacking, so that the proper proportion and sequence of bales are placed "upside down" (tag on bottom edge of each such bale) in the temporary block. No tag man is required when this procedure is followed, but a setup man at the block sometimes is needed.

(4) Uses a lift truck with a rotating clamp, which allows each bale to be placed in the stack with the tag on the top or bottom edge as desired. No outside assistance from other workers is required when this method is used.

Spotting

Spotting of desired bales can be done in many ways. Some of these are: (1) Wrap cotton swatches around the tag wire; (2) place a ball of cotton on top of bale; (3) attach a small colored tag to the bale; (4) attach a colored paper stringer to the bale, using a different color for each lot; and (5) attach a large colored tag with spots of contrasting color, varying the color and spot arrangement for each lot. By using streamers or tags of different colors, it is possible to group bales together by lot in the main aisle of the storage compartment before they are taken to the press area or loading platform. This grouping of bales in the storage area makes the segregating operation easier and faster in the segregating room.

Bale-locating procedures vary according to the preferences of the warehouseman. In small warehouses, little effort is made to maintain a location sheet or system; on the other hand, in some large warehouses, rather elaborate locator systems are maintained. The time required for spotting varies according to the locator system used, in the absence of any system, the size of the warehouse or of the storage area, the type of storage arrangement used, and the order in which the bales are stored.

The fact that bales are not in numerical order may considerably increase spotting time and costs. Storing bales in numerical order is usually easy to do early in the season. But retention of this original order becomes increasingly difficult as the season progresses, because of repeated breaking out for shipment, which disrupts the original arrangement. Also, it becomes more difficult to store newly received bales in an orderly fashion.

An efficient bale locator system is essential in most larger warehouses. As a minimum, each building, compartment, section, bay, and aisle should be identified by numbers, letters, or symbols. When the spotter receives his check sheet, he is then able to proceed quickly and directly to the bays and aisles where the bales desired are located.

Re-Weighing

Re-weighing is an operation that every warehouseman has to do on request. In re-weighing, a crew for breaking out and weighing moves to the area where bales are to be re-weighed. Each such bale is then removed, weighed, and returned to storage.

When flat bales stacked on head in paired rows along cross aisles are to be re-weighed, a lift truck equipped with a breakout attachment can be used to remove bales from the stack, carry them to the scale, and re-store them in the stack. For the weighing itself, a portable platform scale can be used. This method of re-weighing usually involves: (1) A scale crew of 1 or more workers and a portable scale; and (2) 1 breakout truck and operator.

Where flat or compressed bales are stored on head 1 high in a solid block, it is necessary first to move all the bales obstructing the bale to be weighed. Usually 1 or more hand truckers are used to break out and re-store all bales. Again, 1 or more men may be used in the scale crew.

Re-Sampling

Re-sampling is another service that warehousemen must provide on request. Re-sampling involves a procedure somewhat similar to that of re-weighing, except that in some storage patterns a bale usually can be sampled without first breaking out the bale. For this reason, flat bales stacked on head in rows 2 or 3 bales high can be re-sampled much faster and cheaper than bales stored on head in a solid block, or in cordwood stacks. In the former case, samples frequently can be drawn by minor shifts of the position of the bale in the stack; in the latter, the bale to be re-sampled and the bales obstructing it usually have to be removed before a satisfactory sample can be taken. Where the warehouseman has authority to do so, and wishes to avoid later re-sampling at a higher cost, he may take 2 samples when the bale is received. One sample is returned to the owner of the bale and the other is placed, with its identification, in a storage rack.

Segregating

Segregating is done whenever a shipment of more than 1 lot of bales is made at about the same time. It is also done when more than 1 lot of bales is to be assembled in any particular area, such as a compressing area. Bales to be compressed are usually segregated in the compressing room, or in an adjacent compartment. Bales are ordinarily moved to the segregating room by tractor-trailer trains or by clamp trucks. As bales are unloaded from trains they are segregated into lots by the unloader; where they have been transported to the area by clamp truck, they usually are grouped into lots by the same truck. The time and cost for movement of bales from storage compartments to segregating blocks are essentially the same as for movements for comparable distances discussed in the "Transporting Operations" section.

In some warehouses, bales are moved to the segregating room by a 4- or 6-bale clamp truck which simply deposits the load of bales at a point near the segregating blocks. The bales are then placed in these blocks, 1 or 2 bales at a time, by a 2-bale clamp truck. A preferred method, which eliminates the small segregating truck, is first to segregate bales into temporary blocks in the main aisle in the storage area when bales are broken out. The breakout crew can do this as they remove the bales from the storage stacks and move them to the main aisle. When this is done, the 4- or 6-bale clamp truck can move bales of the same lot directly to the correct block in the segregation room, saving the additional segregating operation.

Tightening Up

Usually, scattered "holes" or "gaps" are left in the block or stack, where bales have been broken out or where obstructing bales have been removed. This condition may present no

particular problem if other storage space is available where newly received bales can be stored. Otherwise, the warehouseman has 2 alternatives: (1) Store new bales in the scattered spaces left in each block, or (2) shift "old" bales in each block away from the aisle and toward the wall to provide space next to the aisle. This latter operation, in which the block or stack is rebuilt, is known as "tightening up."

Tightening up may or may not be desirable; the question is one for the decision of the individual warehouseman. He will try to avoid the operation whenever possible, since it often is an additional expense. The time and cost of tightening up usually approximate those of storing by the same method and equipment. Where there is much congestion in the work area, however, the time and cost may be substantially higher. On the other hand, it sometimes is possible to tighten up much of a stack while removing and restoring obstructing bales during breaking out. Where this can be done, tightening up may involve little additional cost.

ORGANIZATION OF OPERATIONS IN THE RECEIVING CYCLE[25]

In previous sections, cotton handling has been discussed mainly in terms of the performance of individual operations, such as unloading, weighing, breaking out, and so on. In some instances, the effect of combining one operation with another was discussed. To complete certain major phases in warehouse handling, such as receiving and shipping, consideration should be given to coordinating, organizing, or integrating various operations. This will be the purpose of the subsequent sections. In this section, some ways of setting up a complete receiving cycle, consisting of all handling operations from unloading to storing, are covered.[26] The organization of the shipping cycle, and of other similar groups of operations, is discussed in succeeding sections.

Combining All Receiving Operations

Until only a few years ago, in many warehouses both large and small, individual bales, one following the other, were passed in succession from one operation to the next. Unloading, weighing, sampling, transporting to storage, and storing were combined and carried on simultaneously. An advantage of this procedure was that within a few minutes after the last bale was unloaded from a particular car or truck, the entire lot had moved completely through the receiving cycle and into permanent storage. A disadvantage, noted earlier, of such a procedure is that it is more difficult to obtain "balance" among the different operations. A more serious disadvantage is that interruptions and irregular delays occurring in any one operation are likely to be passed on to other operations in the cycle. This occurs even where fairly good balance among operations is obtained, based on the average time for each of the various work elements.

In many warehouses, receiving procedures have been abandoned in which all or most operations in the cycle are performed simultaneously. These changes have occurred since about 1952, following recommendations made in an earlier report in this series (*6*, p. 7).

An example follows of a receiving cycle in which all operations are dependent upon each other. Flat bales are received by road truck and unloaded by hand truck onto a truckbed-level platform. Each bale passes through the following sequence of operations: (1) On the road truck, the bale is broken out by hand, placed on a hand truck, and removed from the road truck; (2) the bale is hand trucked directly from the road truck to the weighing station nearby, where it is tagged and weighed on a portable platform scale; (3) the bale is then trucked to the sampling station nearby, where a sample is drawn (as the bale remains on the hand truck) and wrapped; (4) the bale is then trucked 400 feet to a storage area and placed in an untiered storage block;[27] and (5) the hand trucker returns to the road truck and repeats the cycle.

In the procedure outlined, all operations are made mutually dependent by the manner in which bales move from operation to operation in the cycle.

The pace of the entire receiving cycle is thus reduced to that of the slowest operation. Workers performing other operations, therefore, have wait time resulting from their being paced by the slower position. Also, each hand trucker waits at some work station until the operation is completed, and accumulates idle time. And, as has been pointed out, irregular delays and interruptions may further increase the wait time.

[25] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

[26] Integrating of the compressing operation into the receiving cycle is discussed in a later section.

[27] In practice, clamp trucks or tractor-trailer trains would more likely be used for transporting 400 feet. However, hand trucks are retained here to simplify the illustration.

In the example selected, all operations are paced by the unloading operation, which, with 2 breakout men on the truck (as described in the section on unloading), takes 0.84 hour. The labor requirements and total labor and equipment cost of the receiving cycle for 100 bales, when so organized, are as follows:

Dependent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Unload flat bales from road truck	0.84	2	1.68	$1.68
2. Weigh bales on portable platform scale	.84	2	1.68	3.28
3. Sample bales on hand trucks	.84	[1] 3	2.52	2.52
4. Hand truck each bale 50 feet from truck to scale, 50 feet to sampling station, then 400 feet to storage, hand truckers then return to road truck to repeat cycle	.84	13	10.92	11.03
Total	.84	20	16.80	$18.51

[1] In the illustration discussed in the section on sampling, a 6-man sampling crew was used. Here the crew has been reduced to 3 workers in order to obtain better balance consistent with the slower production rate imposed.

Thus, the total cost for unloading, weighing, sampling, and storing by this hand-truck method is $18.51. Part of this cost—much higher than costs of other methods to be discussed—is due to the use of relatively inefficient methods and part to the dependence of the various operations. A roughly equivalent cost is involved in receiving either flat or compressed bales by railroad car when the same methods are used.

Combining Part of the Receiving Operations

Warehousemen may want to group or combine certain operations, making them dependent, while other operations are done independently. This combination may be due to lack of time, space, or labor, or to other reasons. The most common groupings are: (1) Unloading and weighing; (2) unloading, weighing, and sampling; (3) weighing and sampling; and (4) transporting to storage and storing. Temporary blocks are generally used to separate such grouped operations from other operations *(6, p. 7)*. Examples of some of these groupings or combinations of operations are discussed in this section.

Combining Unloading and Weighing

Sometimes unloading and weighing are combined, other operations in the receiving cycle being performed independently. This practice is often followed in warehouses with unloading platforms too narrow or too weak, or otherwise unsuitable, for the use of clamp trucks. In many instances, bales are unloaded by hand truck and immediately weighed. They are later sampled, transported to storage, and stored.

There are several ways by which bales can be handled in this manner. The following example deals with flat bales received by truck and unloaded by hand truck at truckbed level, as in the preceding example. However, handling through the remainder of the receiving cycle is as follows: (1) As the bale is removed from the road truck, it is hand trucked to the scale and weighed (combining unloading and weighing) and then placed in a temporary row block for sampling; (2) bales are block sampled by a roving sampling crew as an independent operation; (3) bales are then transported 400 feet by a 4-bale clamp truck, as another independent operation, and unloaded into a temporary block in the storage compartment; and (4) as a final independent operation, the bales are moved 50 feet by 2-bale clamp truck and stored on head in a double-row stack 2 bales high. The labor requirements and total labor and equipment cost for each of the operations in such a receiving cycle for 100 bales are as follows:

Dependent operations (combining unloading and weighing)	Elapsed hours	Number of men	Man-hours	Total labor and equitpmen cost
1. Unload flat bales from road truck	0.84	2	1.68	$1.68
2. Weigh bales on portable form scale	.84	2	1.68	3.28
3. Hand truck each bale 50 feet from truck to scale, then 50 feet to sampling block; hand truckers then return to road truck to repeat cycle	.84	4	3.36	3.39
Independent operations				
1. Sample bales in row block	.92	2	1.84	1.84
2. Transport bales 400 feet to temporary block in storage area by 4-bale clamp truck	.46	1	.46	1.40
3. Stack bales on head 2-high by 2-bale clamp truck	.51	1	.51	1.25
Total	------	------	9.53	$12.84

Thus, the total cost for receiving flat bales in this manner is $12.84.

Combining Unloading, Weighing, and Sampling

Some warehousemen combine the unloading, weighing, and sampling operations, but transport bales to storage and store them as independent operations. If, in the preceding example, bales were sampled on hand trucks, instead of while in a block, the process would represent a receiving cycle in which unloading, weighing, and sampling are the dependent operations. Operations in the receiving cycle for 100 bales then would be as follows:

Dependent operations (combining unloading, weighing, and sampling)	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Unload flat bales from road truck	0.84	2	1.68	$1.68
2. Weigh bales on portable platform scale	.84	2	1.68	3.28
3. Sample bales on hand trucks	.84	3	2.52	2.52
4. Hand truck each bale 50 feet from road truck to scale, then 50 feet from scale to sampling station, then 50 feet to temporary block; hand truckers then return to road truck to repeat cycle	.84	5	4.20	4.24
Independent operations				
1. Transport bales 400 feet to temporary block in storage area by 4-bale clamp truck	.46	1	.46	1.40
2. Stack bales on head 2 high by 2-bale clamp truck	.51	1	.51	1.25
Total			11.05	$14.37

Thus, bales are received at a cost of $14.37. Also, a similar procedure is applicable to bales unloaded at ground level by the push-off method, and to bales received by railroad cars. Total man-hours and costs change, of course, with the types of bales received and the methods of unloading, transporting, and storing used.

Combining Weighing and Sampling

Many warehousemen combine weighing and sampling, but perform other operations in the receiving cycle independently. In such cases, clamp trucks usually are used for unloading and for stacking, and clamp trucks or tractor-trailer trains for transporting to the storage area, whereas hand trucks are used in weighing and sampling. In the following example, this procedure is followed: (1) Flat bales are unloaded from a road truck by a 2-bale clamp truck working at ground level, and are moved 50 feet to a temporary block; (2) later, bales are removed from this block by hand truck and, as a combined operation, are weighed on a portable platform scale and sampled on the hand trucks, and after sampling they are hand trucked to a temporary block; (3) still later, they are transported to the storage point by a 4-bale clamp truck; and (4) they are stored on head in stacks 2 bales high by a 2-bale clamp truck. The time, labor requirements, and cost per 100 bales for each operation were estimated as follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Unload flat bales from road truck	0.84	2	1.68	$1.68
2. Hand truck each bale 50 feet to a temporary block, return empty 50 feet to road truck to repeat cycle	.84	2	1.68	1.70
Dependent operations (combining weighing and sampling)				
1. Weigh bales on portable platform scale	.48	2	.96	1.87
2. Sample bales on hand trucks	.48	6	2.88	2.88
3. Hand truck each bale 50 feet from block to scale; then 50 feet from scale to sampling station; then 50 feet to temporary block; hand trucker returns to first block to repeat cycle	.48	6	2.88	2.91
Independent operations				
1. Transport bales 400 feet to a temporary block in storage area by 4-bale clamp truck	.46	1	.46	1.40
2. Stack bales on head 2-high by 2-bale clamp truck	.51	1	.51	1.25
Total			11.05	$13.69

Thus, when this particular sequence of operations is used in receiving bales, the cost is $13.69.

Compressed bales unloaded from a railroad car by clamp truck at car-floor level often are handled through the remainder of the receiving cycle in much the same way as in the preceding example. However, as noted in the section on sampling, the two types of bales are sampled differently. A second example of combining weighing and sampling is included in the receiv-

ing procedure for compressed bales described below. One side of the compressed bale is sampled just before the bale is removed by hand truck from the first block, and the other side is sampled just after the bale is placed in the second block. The bale is weighed before it is put in the second block, thus making the two operations mutually dependent. Bales are transported to the storage area by a 4-bale clamp truck, and later, as an independent operation, are stored 5 bales high in a cordwood stack by a 2-bale clamp truck. The complete receiving procedure, for 100 compressed bales, is then as follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Unload compressed bales from car by 2-bale clamp truck, and move 50 feet into temporary block	0. 81	1	0. 81	$1. 98
Dependent operations (combining weighing and sampling)				
1. Weigh bales on portable platform scale	[1]. 48	2	. 96	1. 87
2. Sample bales in block, on one side prior to and the other side after weighing	. 48	5	2. 40	2. 40
3. Hand truck each bale 50 feet from block to scale, then 50 feet from scale to second block; hand trucker returns to first block to repeat cycle	. 48	4	1. 92	1. 94
Independent operations				
1. Transport bales 400 feet by 4-bale clamp truck to temporary block in storage area	. 48	1	. 48	1. 46
2. Store bales 5 high in cordwood stacks by 2-bale clamp truck	. 87	1	. 87	2. 13
Total			7. 44	$11. 78

[1] The elapsed hours for weighing are treated as though they are the same for both flat and compressed bales, although there may be a difference of a few seconds per bale.

The total cost for receiving, when this procedure is used, is therefore $11.78.

Transporting to Storage and Storing

In the section "Transporting Operations," it was pointed out that whenever a job best done by clamp truck immediately precedes or follows a transporting operation, it might be cheaper to use the clamp truck for transporting, too. In this way the two jobs can be done in a continuing sequence by the same machine and operator. "Storing" is an operation that normally follows a transporting operation and usually can be done best by a clamp truck. Each worker first transports, then stores a load of bales, completing both operations as one independent operation. Because of this self-balancing feature, there is no wait time.

Separation of Operations

In the following receiving cycle, all operations are performed independently. Where a 2-bale clamp truck and a hand-propelled mobile beam scale are used, the receiving is as follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Unload flat bales from road truck at ground level by 2-bale clamp truck, and move 50 feet into a temporary row block	0. 77	1	0. 77	$1. 89
2. Weigh bales in row block by hand-propelled mobile beam scale	. 48	5	2. 40	3. 15
3. Sample bales in row block	. 92	2	1. 84	1. 84
4. Transport bales 400 feet to storage and stack on head 2 bales high by 2-bale clamp truck	1. 26	1	1. 26	3. 08
Total			6. 27	$9. 96

Therefore, when equipment and crews are used as indicated, the total computed cost of receiving is $9.96.

Where a 4-bale clamp truck is used, the total receiving cost is reduced by about 20 percent, as shown by the following tabulation:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Unload flat bales from road truck at ground level by 4-bale clamp truck, move bales 50 feet into temporary row block	0. 46	1	0. 46	$1. 40
2. Weigh bales in row block by hand-propelled mobile beam scale	. 48	5	2. 40	3. 15
3. Sample bales in row block	. 92	2	1. 84	1. 84
4. Transport bales 400 feet to storage and stack on head 2 bales high by 4-bale clamp truck	. 52	1	. 52	1. 59
Total			5. 22	$7. 98

Thus, the total cost of receiving, when the operations are organized in this way, is $7.98.

In this receiving operation, the cost of transporting bales 400 feet to the storage area and stacking them, as a single operation, is $1.59 when a 4-bale clamp truck is used. This cost might be compared with that of doing the same jobs in two separate operations, using other efficient means for transporting. As an example, bales may first be transported to the storage point by 1-man trailer train and unloaded into a temporary block. As the second stage, assume that a 4-bale clamp truck draws bales from this block and stacks them. Following is a comparison of the costs of the two methods:

1. Transport bales 400 feet by 1-man tractor-trailer train and stack by 4-bale clamp truck	$2.30
2. Transport bales 400 feet and stack by 4-bale clamp truck (continuous operation)	1.59
Difference	$.71

Thus, in this situation, it is considerably cheaper to use the 4-bale clamp truck to combine the 2 operations than to split the transporting and stacking jobs between the trailer train and the 4-bale truck.

Advantages From Separation of Operations

In the examples given, all or part of the receiving operations were combined. The next logical step is to consider the complete separation of operations, which in certain situations has definite advantages. The considerations involved are (1) the relative efficiency of alternative available equipment in transporting and in storing, and (2) the savings that result when the same workers do different jobs in succession: for example, through elimination of extra setdown and pickup elements and avoidance of wait time.

Most receiving operations involve different crews performing different jobs—unloading, weighing, sampling, transporting, and storing. Where receiving operations are of this type, it usually is best to perform each operation independently of the others. The following advantages accrue:

1. Each operation may be performed with maximum efficiency.
2. The production rate of any operation may be increased or decreased as desired, by varying the crew size or its organization, without affecting the rate of any other operation.
3. Crew size can be better adjusted to conform to the needs of other competing warehouse operations.
4. The same workers may be used on different operations at different times, thus reducing the total number of workers required.
5. Scheduling of operations can be done more efficiently, making better use of time.
6. Equipment can be used more efficiently.
7. Wait time arising from irregular delays, interruptions, and the normal variation in work time in any one operation is not passed along to other operations.

Because of the advantages just outlined, it usually pays warehousemen to keep operations independent when possible. This holds for the small warehouse as well as the large one, and for the hand operation as well as the mechanized one. One method of using independent operations in receiving flat bales and the resulting cost is illustrated (on the basis of 100-bale lots) by the following procedure:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Unload flat bales from road trucks at ground level by 4-bale clamp truck, and move 50 feet into a temporary row block	0.46	1	0.46	$1.40
2. Tie tags on bales in row block	.20	1	.20	.20
3. Weigh bales in row blocks by motor-propelled mobile beam scale	.35	3	1.05	2.05
4. Sample bales in row block	.92	2	1.84	1.84
5. Transport bales 400 feet to storage and stack on head 2 bales high by 4-bale clamp truck	.52	1	.52	1.59
Total			4.07	$7.08

A warehouseman can often use clamp trucks for more than 1 operation when all operations are performed independently. In the receiving operation just described, a 4-bale clamp truck is used to unload bales from road trucks. Also, when the 4-bale clamp truck operator has a lull in the unloading operation, he can use the same machine for transporting bales to storage and storing. This procedure, where it can be used, generally results in an efficient use of labor and equipment. However, 2- or 3-bale clamp trucks can be used to unload road trucks. The unloading cost would be increased by $0.34 if a 2-bale clamp truck were used, and $0.15 for a 3-bale

clamp truck. Also, a 3-bale clamp truck can be used to transport and store bales at a cost increase of $0.62.

Where complete independence of operations cannot be fully achieved or is not practical, the warehouseman still has one recourse: He can so distribute his workers as to obtain the best balance possible among the combined operations.

It was possible to give only a few examples in this section of the many possible ways of receiving cotton. In the main, they illustrate what occurs when 2 or more operations are combined. They also indicate the crew sizes likely to give the best balance for the particular combinations of operations shown. In this respect, these examples differ from many of the receiving methods found in practice. Many warehousemen combine operations without adjusting the crew sizes to conform to the new production rate. They thus waste much labor that might otherwise be saved.

ORGANIZATION OF OPERATIONS IN THE SHIPPING CYCLE[28]

Whereas the receiving cycle was composed of 5 major handling operations, the shipping cycle is composed of only 3. Therefore, fewer combinations of operations are possible.

The 3 major operations in shipping are (1) breaking out, (2) transporting to the loading area, and (3) loading into a car or truck.[29] In addition, other activities incidental to shipping —which often affect the handling in one way or another—are (a) spotting, (b) segregating by shipping lot, and (c) checking. In this section, examples are given of some of the ways of organizing handling in the shipping cycle—examples which can serve as guides for warehousemen.

Combining All Shipping Operations

Manual and Hand-Truck Systems

Where hand trucks and manual methods are used for all receiving operations, they are likely to be used also in shipping. If each bale, as it is broken out, is immediately transported to the car or truck and loaded, each of the 3 operations—breaking out, transporting, and loading —become dependent upon each other. Such dependence has the same effect on shipping-cycle operations as it does on those in the receiving cycle. The production rate of all operations conforms to that of the slowest operation in the group, and delays in 1 operation may be passed on to others.

In the preceding section, an example was given of a receiving procedure for flat bales in which all operations were combined and carried on simultaneously. A similar procedure may be used in shipping where bales are broken out by hand truck or by a combination of manual breakout and hand-truck carry-off, depending on the storage arrangement. Bales would be hand trucked to the loading point and hand loaded into cars or road trucks.

In the following illustration, it is assumed that flat bales are to be broken out by hand truck (as described in the section on breakout, page 48) from solid blocks, in which they are stored on head 1 bale high and 15 bales deep from the aisle. Also it is assumed that, as the bales are broken out, they are transported by hand truck 400 feet to a railroad car. Bales are to be loaded by a crew consisting of (1) 28 hand truckers (number required at 400 feet travel distance) who transport the bales to the car and set them down in place inside the car, and (2) 6 loaders who complete by hand the positioning of bales placed by the hand truckers in the bottom tier, and lift and position bales in the top tier. The time and costs per 100 bales for the combined dependent operations are as follows:

Dependent operations (combining breaking out, transporting, and loading)	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by hand truck from solid blocks 1 bale high and 15 bales deep, transport 400 feet to car, and set down inside car	1. 16	28	32. 48	$32. 80
2. Complete loading in car	1. 16	6	6. 96	6. 96
Total	1. 16	34	39. 44	$39. 76

Manual and Hand-Truck and Machine Systems

There are several other ways, of course, by which operations in the shipping cycle are combined. One of the most common ways is to carry on all 3 operations for a given lot of bales at the same time. Breaking out usually is the slowest operation, and the other 2 operations are slowed down to conform to the breakout rate.

[28] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

[29] Integrating of the compressing operation into the shipping cycle is discussed in the next section.

In the section on receiving, examples were given of operations in which flat bales were: (1) Unloaded, weighed, or sampled using hand trucks; (2) transported to storage area by a 4-bale clamp truck; and (3) stacked on head 2 bales high by a 2-bale clamp truck. Dependence of shipping operations may be illustrated by use of the same equipment to break out, transport, and load bales. Where these shipping operations are combined, the time and costs are as follows:

Dependent operations (combining breaking out, transporting, and loading)	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by manual and hand-truck method from stacks 2 bales high, and pre-position bales in main aisle for pickup by 4-bale clamp truck	4. 25	4	17. 00	$17. 04
2. Transport bales 400 feet by 4-bale clamp truck to temporary block 50 feet from car	4. 25	1	4. 25	12. 96
3. Load bales into car from block by 2-bale clamp truck	4. 25	1	4. 25	10. 41
Total	4. 25	6	25. 50	$40. 41

With the equipment indicated, bales can be transported and loaded into the car in much less than 4.25 hours—the time required for breaking out by the manual and hand-truck method. Bales can be independently transported by 4-bale clamp truck in 0.46 hour and independently loaded by clamp truck in 0.75 hour. Yet in the combined operations, both transporting and loading are slowed to 4.25 hours because they cannot be completed in any less time than is needed to break out. The difference between 4.25 hours and the time required for transporting and loading independently represents wait time for the labor and equipment used in transporting and loading.

Since wait time as well as work time must be paid for, the shipping cost, when the operations are done simultaneously, must be computed on the basis of 4.25 hours for each operation. The total cost, then comes to $40.41.

Reductions in cost can be made by changes in method, equipment, and organization. For example, the elapsed time—and also the cost—of breaking out can be reduced substantially by using a lift truck equipped with a breakout attachment instead of the manual and hand-truck method. Since a reduction in elapsed time for breaking out reduces also the time for transporting and loading, total cost per 100 bales for the combined operations is also reduced. With this method, time and costs are as follows:

Dependent operations (combining breaking out, transporting, and loading)	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by lift truck with breakout attachment from stacks 2 bales high, and pre-position bales in the main aisle for pickup by 4-bale clamp truck	1. 37	1	1. 37	$3. 29
2. Transport bales 400 feet by 4-bale clamp truck to temporary block 50 feet from car	1. 37	1	1. 37	4. 18
3. Load bales into car from block by 2-bale clamp truck	1. 37	1	1. 37	3. 36
Total	1. 37	3	4. 11	$10. 83

Thus, by changing the method of breaking out, the entire shipping cycle can be completed in 1.37 hours, and the total shipping cost reduced from $40.41 to $10.83. As discussed later, however, this cost can be reduced further by doing these same operations independently.

Where clamp trucks used in transporting from the breakout area to the loading area can be efficiently used in loading also, it often is desirable to combine these jobs into a single operation using the same clamp trucks. In the following example, bales are transported to the loading area by a 2-bale clamp truck and loaded by a second 2-bale clamp truck; transporting and loading are not combined into a single operation. The time and costs per 100 bales with all operations done simultaneously are then as follows:

Dependent operations (combining breaking out, transporting, and loading)	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by manual and hand-truck method from stacks 2 bales high, and place in temporary block in main aisle	4. 25	4	17. 00	$17. 04
2. Transport bales 400 feet by 2-bale clamp truck to temporary block 50 feet from car	4. 25	1	4. 25	10. 41
3. Load bales into car from block by 2-bale clamp truck	4. 25	1	4. 25	10. 41
Total	4. 25	6	25. 50	$37. 86

In the above example, both transporting and loading are slowed to conform to the breakout rate of 4.25 hours. But bales can be independently transported 400 feet by a 2-bale clamp truck in 1.20 hours at a cost of $2.94; and bales can be independently loaded by a 2-bale clamp truck in 0.75 hour at a cost of $1.84. With the transporting truck idle over 3 hours, and the loading truck idle 3.50 hours, it is obvious that 2 trucks are not necessary.

In the following example, transporting and loading are combined into a single operation using only 1 truck but with operations still done simultaneously. The time and costs per 100 bales are then as follows:

Dependent operations (combining breaking out, transporting, and loading)	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by manual and hand-truck method from stacks 2 bales high, and place in temporary block in main aisle	4. 25	4	17. 00	$17. 04
2. Transport bales 400 feet to car by 2-bale clamp truck, and load car	4. 25	1	4. 25	10. 41
Total	4. 25	5	21. 25	$27. 45

By combining transporting and loading, thus eliminating 1 clamp truck and operator, the cost is reduced from $37.86 to $27.45. But this organization of the cycle is still wasteful. It slows the transporting-loading operation — which requires 1.50 hours—to conform to the breakout time of 4.25 hours. Thus, the truck and operator are forced to spend 2.75 hours in waiting on the breakout crew. The transporting-loading operation, to be independent of a slower breakout operation, must begin only after breaking out has progressed far enough to remove its influence.

Separation of Operations

It usually is possible to separate the shipping operations so that each can be done independently. This usually is to be desired except where transporting can be efficiently combined with loading.

Separation of Transporting-Loading From Breaking Out

If the transporting-loading operations are done independently of breaking out, the shipping time and cost per 100 bales are as follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by manual and hand-truck method from stacks 2 bales high, and place in temporary block in main aisle	4. 25	4	17. 00	$17. 04
2. Transport bales 400 feet to car by 2-bale clamp truck, and load car	1. 50	1	1. 50	3. 68
Total			18. 50	$20. 72

Thus, by separating the transporting-loading operation from breaking out, the cost is reduced from $27.45 to $20.72.

A similar organization of the shipping cycle, with similar advantages, applies when the more efficient machine method of breaking out is used. The time and costs per 100 bales are then as follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by lift truck with breakout attachment from stacks 2 bales high, and place bales in temporary block in main aisle	1. 37	1	1. 37	$3. 29
2. Transport bales 400 feet to car by 2-bale clamp truck, and load car	1. 50	1	1. 50	3. 68
Total			2. 87	$6. 97

By mechanizing the breakout operation, while otherwise following the same handling procedure as in the previous example, the total cost of shipping is reduced from $20.72 to $6.97.

The only illustrations given of combined transporting-loading operations have been those in which the same 2-bale clamp truck is used for both tasks. Other types of cotton-handling equipment that lend themselves to similar combinations are the 3-bale and 4-bale clamp trucks. In some situations, the 6-bale truck may be so used. A 3-bale clamp truck can transport either 3 flat or 3 compressed bales at a time. It can also load compressed bales into cars 3 bales at a time. But most car doors are too narrow for 3 flat bales, grasped side-to-side by the clamps. So, if flat bales are transported to a car 3 at a time, it is necessary, first, to set them down, and then pick up 2 bales for loading into the car. It is not practical, therefore, to combine transporting and loading of flat bales with a 3-bale clamp truck.

Two examples are given here to illustrate a shipping cycle for compressed bales where a combined transporting-loading operation by a 3-bale clamp truck is used. This operation is performed independently of the breakout operation. In the first example, bales are broken out of solid blocks 1 bale high by means of the breakout attachment; in the second example, they are broken out of cordwood stacks by the manual and boom-truck method.

Where compressed bales are broken out of solid blocks with a breakout attachment, the organization of the cycle, time and costs per 100 bales are as follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out compressed bales by lift truck with breakout attachment from solid blocks 1 bale high and 5 bales deep from the cross aisle, and place in temporary block in main aisle	1. 31	1	1. 31	$3. 14
2. Transport bales 400 feet to car by 3-bale clamp truck, and load car	1. 16	1	1. 16	3. 02
Total			2. 47	$6. 16

Therefore, the total cost is $6.16. On the other hand, if it is necessary to break out compressed bales from cordwood stacks 5 bales high, the total cost of shipping is increased to about $22.39 because of the higher breakout cost. The time and cost per 100 bales with the manual and boom-truck method is shown below:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out compressed bales by manual and boom-truck method from cordwood stacks 5 bales high, leaving bales on head in cross aisle	4. 77	2	9. 54	$17. 41
2. Move bales (later) in tandem, 2 at a time, 40 feet to temporary block in main aisle by lift truck with extended clamps	. 80	1	. 80	1. 96
3. Transport bales 400 feet to car by 3-bale clamp truck, and load car	1. 16	1	1. 16	3. 02
Total			11. 50	$22. 39

The following example is one in which a 4-bale clamp truck is used to transport flat bales and to load them onto a road truck from ground level. Bales are broken out with a breakout attachment from on-head stacks 2 bales high. The cycle of operations, resulting in a total labor and equipment cost of $5.88, would then be as follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by lift truck with breakout attachment from stacks 2 bales high, and place bales in temporary block in main aisle	1. 37	1	1. 37	$3. 29
2. Transport bales 400 feet to road truck by 4-bale clamp truck, and load road truck from ground level	. 85	1	. 85	2. 59
Total			2. 22	$5. 88

Separation of Transporting, Loading, and Breaking Out

When 1 type or size of equipment is most efficient for transporting but another type or size must be used for loading, the 2 operations cannot be combined into a single operation in the manner described above. Bales are brought to the loading point and placed in a temporary block by 1 type of equipment; they are then picked up from this block and loaded by the other type equipment. Such a procedure permits the 2 operations to be performed independently without 1 operation retarding the other.

A few typical examples of shipping cycles that have been organized to provide separation of the 3 operations are shown below. The first example follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by manual- and hand-truck method from stacks 2 bales high, and pre-position bales in main aisle for pickup by 4-bale clamp truck	4. 25	4	17. 00	$17. 04
2. Transport bales 400 feet by 4-bale clamp truck to temporary block 50 feet from car	. 46	1	. 46	1. 40
3. Load bales into car from block by 2-bale clamp truck	. 75	1	. 75	1. 84
Total			18. 21	$20. 28

This procedure is identical with one shown earlier on page 67, except that there all operations were performed simultaneously, and therefore were slowed to the 4.25 hours required for breaking out. As a result of separating these operations in the above example, the total labor and equipment cost for shipping was reduced to $20.28. This compares with $40.41 for the dependent operations shown on page 67.

The next example shows the same independent operations, except that breaking out is by machine instead of by hand. Then the time and costs per 100 bales are as follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by lift truck with break-out attachment from stacks 2 bales high, and pre-position bales in main aisle for pick-up by 4-bale clamp truck	1. 37	1	1. 37	$3. 29
2. Transport bales 400 feet by 4-bale clamp truck to temporary block 50 feet from car	. 46	1	. 46	1. 40
3. Load bales into car from block by 2-bale clamp truck	. 75	1	. 75	1. 84
Total	------	------	2. 58	$6. 53

This procedure is identical with that shown on page 67, except that all operations are performed independently. By separating the operations, the total cost is reduced from $10.83 to $6.53. Also this cost is slightly below the $6.97 for transporting and loading cars by the same 2-bale clamp truck (p. 68). These 2 methods represent the 2 most inexpensive methods covered.

In the following example, compressed bales are broken out of solid blocks by machine, transported by a 4-bale clamp truck to the car, and loaded by a 3-bale truck. The cycle, time, and costs per 100 bales are then as follows:

Independent operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out compressed bales by lift truck with breakout attachment from solid blocks 1 bale high and 5 bales deep from the cross aisle, and place in temporary block in main aisle	1. 31	1	1. 31	$3. 14
2. Transport bales 400 feet by 4-bale clamp truck to temporary block 50 feet from car	. 46	1	. 46	1. 40
3. Load bales into car from block by 3-bale clamp truck	. 66	1	. 66	1. 72
Total	------	------	2. 43	$6. 26

Thus, when compressed bales are handled in the manner indicated, the shipping cost is $6.26. But if all operations were combined and performed simultaneously, the total cost for shipping would be increased to $10.55.

DIRECT LABOR AND EQUIPMENT REQUIRED AND COSTS TO MOVE BALES INTO AND OUT OF WAREHOUSES AND COMPRESSES[30]

This section brings together the labor and equipment requirements and cost of moving bales of cotton into and out of warehouses under various conditions. Management, warehouse maintenance, overhead, and facility costs are not included in the receiving and shipping costs. Therefore, these cost estimates do not reflect total costs to the warehouseman. However, the labor and equipment requirements and costs given can be used as a guide to achieve cost reductions in various warehouse bale handling operations. Compressing costs are not included where compressing is involved; but costs of bale handling that immediately precede and follow the compressing operations are included. The organization of the receiving and shipping cycle and of the movement of bales to and from the press was discussed in previous sections. In this section, the results of selected procedures from each of these sections are discussed in terms of total in-and-out handling cost. With so many possible variations, it is not practicable, of course, to consider more than a few. Examples in this section and in previous sections were chosen to illustrate procedures that might be used in different situations, and how they compare in efficiency and cost.

[30] All time, man-hour, and cost comparisons shown in this section are, unless otherwise indicated, on the basis of a 100-bale unit.

Most equipment used in receiving operations at a warehouse is likely to be used also in some shipping operations. In some situations, special equipment may be used in weighing, stacking, or breaking out. But the whole system of handling in a warehouse often can be described in terms of particular methods or equipment used, or of particular combinations of methods and equipment.

Warehouses Without Compresses

Manual and Hand-Truck Systems

Manual methods of handling bales are less efficient and more expensive than mechanical methods. However, some manual handling may be necessary in weighing, sampling, and certain types of breakout operations. However, the extent to which manual methods are used when suitable mechanical methods are available indicates the extent to which handling costs may be higher than necessary. Continued extensive use of manual and hand-truck methods generally occurs in the smaller country warehouses.

In the section on "Receiving," an example was given (p. 62) of receiving flat bales, with simultaneous operations by manual and hand-truck methods. A 20-man crew, consisting of a 2-man breakout crew on the truck, a 2-man scale crew, a 3-man sampling crew, and 13 hand truckers was used. Elapsed time for these concurrent operations was 0.84 hour, labor required 16.80 man-hours, and total labor and equipment cost $18.51.

In the section on "Shipping," a similar example was given (p. 66) where 28 hand truckers transported bales 400 feet, and 6 "loaders" loaded them into a rail car. With this 34-man crew, the elapsed time was 1.16 hours, and 39.44 man-hours of labor were required, and the total shipping cost was $39.76. An 18-man shipping crew, however, is a more practical size for a warehouseman operating with a 20-man receiving crew. This 18-man crew is used in the same way as the 34-man crew except that 12 instead of 28 hand truckers are used. Then the elapsed time for shipping is increased to 2.67 hours, labor requirements are increased to 48.06 man-hours, and cost is increased to $48.38.

When this latter shipping procedure is "added to" the receiving procedure noted above, the total labor requirements for receiving and shipping are 64.86 man-hours, and the total cost is $66.89. Assuming that these procedures are employed in a warehouse that annually receives and ships 10,000 bales, about 6,500 man-hours of labor for handling are required for a season at a total cost of about $6,700.

Manual and Hand-Truck and Machine Systems

In contrast to the relatively inefficient manual and hand-truck systems of warehouse handling are the more efficient semimechanized systems. In these latter systems, powered equipment is used in place of hand equipment in many of the operations in both the receiving and shipping cycles, and improved manual methods are substituted where mechanization of an operation is not practical. All operations are performed independently.

In the section on "Receiving," an example was given (p. 64) of a relatively efficient method that can be used by many warehousemen receiving flat bales. The total labor requirements were 6.27 man-hours, and the total labor and equipment cost was $9.96. In the section on "Shipping," an example was given (p. 68) of a relatively efficient method requiring 2.87 man-hours at a cost of $6.97. Thus, the total labor requirements for both receiving and shipping were 9.14 man-hours per 100 bales, and the total cost was $16.93. This compares with a receiving and shipping cost of $66.89 for the manual and hand-truck procedures assumed in the preceding example. Assuming that a warehouseman using these semimechanized methods receives and ships 10,000 bales per year, about 900 man-hours of labor would be required for all handling in receiving and shipping at a total cost of about $1,700. This is $5,000 less than the $6,700 cost of manual and hand-truck procedure.

Warehouses With Compresses

Manual and Hand-Truck and Machine Systems

The preceding examples pertained to warehouses that store and ship flat bales, performing no compressing services. Most cotton warehouses are of this type. On the other hand, cotton compresses are the largest plants in the industry. Also, since most flat bales are compressed before being shipped to mills or ports, they normally are received, serviced, and shipped by a compress at some time or other.

Most compresses are engaged as much in storing as in compressing. Such plants generally are equipped to handle and store relatively large quantities of bales. The illustrations that follow indicate the costs involved, under particular conditions, in moving nontransit cotton into, within, and out of a compress facility.

Compressmen may press bales (1) on shipment, (2) on arrival, and (3) during storage. The following factors are considered before deciding when to compress bales: (1) Availability of labor; (2) relative scarcity of storage space; (3) local weather conditions; (4) size

of cotton crop; and (5) anticipated movement of bales into and out of the warehouse. Ordinarily a compressman receiving bales from gins or country warehouses prefers to store flat bales on receipt, compressing them only on shipment, to either standard or high density as required. This reduces breakout costs, speeds handling during the receiving period, and permits better scheduling of operations and better utilization of labor and equipment. Because of the scarcity of storage space, however, a compressman may find he must compress bales on arrival. Other warehousemen may prefer to compress during the slack months immediately following the harvesting and ginning season, but there are additional costs in later removing bales from storage, pressing, and returning them to storage.

Compressing on shipment.—The compressing operation is integrated into the following shipping cycle. A pressing rate of 100 bales per hour is assumed, and the new cycle requirements and costs are detailed below:

Compressing-shipping operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Break out flat bales by lift truck with breakout attachment from stacks 2 bales high, and segregate according to shipping lot in temporary blocks in main aisle	1. 37	1	1. 37	$3. 29
2. Transport bales 400 feet to pressing blocks in segregation area by 4-bale clamp truck	. 46	1	. 46	1. 40
3. Feed dinky press: (a) Transport bales 160 feet to small temporary block near dinky, by 2-bale clamp truck, while (b) a hand trucker picks up single bales on ball side, trucks each bale 15 feet to the dinky press and unloads it into dinky	1. 00	2	2. 00	3. 46
4. Remove compressed bales from main press: Hoist man moves bales by jib crane to buck bar	1. 00	1	1 00	1. 00
5. Load bales into car 50 feet from buck bar by 2-bale clamp truck	1. 00	1	1. 00	2. 45
Total			5. 83	$11. 60

It is assumed that the method described on p. 65 is used in the receiving operation; the labor required is 4.07 man-hours and the cost $7.08. The combined costs for the handling involved in receiving, compressing, and shipping per 100 bales for these methods are as follows:

Receiving cycle	$7.08
Compressing-shipping cycle	11.60
Total	$18.68

The total labor requirements for the in-and-out movement are 9.90 man-hours. Assuming that a compress plant receives and ships 50,000 bales a year, using the above methods, the in-and-out movement of bales involves about 5,000 man-hours of labor and a cost of over $9,300.

Two points in particular about this compressing-shipping operation should not be overlooked. The first is that bales are segregated into shipping lots near the breakout point with no extra handling time. Bales can be transported and placed in segregated compressing or shipping blocks in the press room in one operation by clamp truck. The same system is applicable to small or large warehouses. The second point is that when compressing is introduced into the shipping cycle, it affects the elapsed time for all jobs that are necessarily geared to the pressing rate. The operations thus paced by the pressing rate are: (1) Feeding bales to the dinky press, (2) removing bales from the main press, and (3) loading. Only 0.77 hour is required to load compressed bales with a 2-bale clamp truck when loading is done independently from a block 50 feet from the car. But loading actually requires 1 hour, as it can proceed no faster than compressing. Therefore a 2-bale clamp truck can load a car located up to 150 feet from the block.

Yet there is no advantage in setting up temporary blocks along the loading platform so that loading can be done independently. The bales have to be cleared from the press area as quickly as possible. Placing bales in temporary blocks 50 feet from a car and 15 feet from the press with a 2-bale clamp truck requires 1 hour per 100 bales and costs $2.45. A loading time of 0.77 hour and a loading cost of $1.89 must still be added, making the total cost of loading $4.34. The least expensive way to load bales in this situation is to load them directly off the press.

Compressing on receipt.—Where bales are pressed on arrival at the warehouse as part of the receiving cycle, the same basic receiving procedure is used as in the preceding example.

The only changes are: (1) After sampling, bales are moved to the pressing room rather than to the storage area; and (2) after pressing, the compressed bales are taken to storage and placed in cordwood stacks. Assuming a pressing rate of 100 bales per hour, the modified receiving procedure and costs are shown below:

Compressing-receiving operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Unload flat bales from road trucks at ground level by a 4-bale clamp truck, and move bales 50 feet to a row block	0. 46	1	0. 46	$1. 40
2. Tie tags on bales in row block	. 20	1	. 20	. 20
3. Weigh bales in row block by motor-propelled mobile beam scale	. 35	3	1. 05	2. 05
4. Sample bales in row block	. 92	2	1. 84	1. 84
5. Transport bales 200 feet to pressing block in segregation area by 4-bale clamp truck	. 34	1	. 34	1. 04
6. Feed dinky press: (a) Transport bales 160 feet to small temporary block near dinky, by 2-bale clamp truck, while (b) a hand trucker picks up single bales on ball side, trucks each bale 15 feet to the dinky press and unloads it into dinky	1. 00	2	2. 00	3. 46
7. Remove compressed bales from main press: Hoist man moves bales by jib crane to buck bar	1. 00	1	1. 00	1. 00
8. Transport bales 400 feet to storage and store 5 bales high in cordwood stacks by two 2-bale clamp trucks	1. 00	2	2. 00	4. 90
Total	------	------	8. 89	$15. 89

Two 2-bale clamp trucks are needed to transport and stack bales at a distance of 400 feet from the press. One truck, whether 2-bale or 3-bale, cannot do the transporting-storing job within the 1 hour required for a pressing rate of 100 bales per hour. It is cheaper, in this situation, to use two 2-bale clamp trucks than any other type. (Two 3-bale clamp trucks would cost $5.67 per hour, and a 4-bale truck has difficulty in cordwooding compressed bales.) The cost of transporting-storing by this procedure is $4.90. Stacking with transporting and storing combined into a single operation may be cheapest when the operation is paced by the pressing rate. Stacking independently of both transporting and the pressing rate can be done, but the savings may be minor.

It is assumed that the method described on page 69 is used in the shipping operation; the labor required is 11.50 man-hours and the cost $22.39. The total direct handling cost, in moving bales into and out of the warehouse as indicated above, is computed as follows:

Compress-receiving cycle	$15.89
Shipping cycle	22.39
Total (per 100 bales)	$38.28

The total labor requirements for this handling are 20.39 man-hours. Again assuming that 50,000 bales are received and shipped by these methods, about 10,300 man-hours of labor are required, and costs are about $19,300.

Removing from storage, compressing, and returning to storage.—The last of the 3 situations here considered involves: (1) Storing bales flat on arrival; (2) removing them from storage and compressing them at some later time; (3) returning them to storage in compressed form, and (4) breaking out and loading. The receiving cycle can be the same as that shown on page 65, and the shipping cycle for compressed bales the same as that shown on page 69. The only change to be made is the introduction of a new cycle of operations concerned solely with: (1) Removing bales from storage; (2) compressing them; and (3) returning them immediately to storage. This group of operations is what is often called "press and set back."

Bales can be removed from stacks "as they come" and transported to the press room. In this operation, bales are removed from stacks by clamp truck simply by reversing the procedure used in stacking. The other necessary jobs in the compressing operations are identical with some of those covered in the operations described on pages 56 and 58. The breakdown of operations for such a movement is then as follows:

Compressing operations	Elapsed hours	Number of men	Man-hours	Total labor and equipment cost
1. Remove flat bales from stacks 2 bales high by 4-bale clamp truck and transport 400 feet to pressing blocks in segregation area	0. 57	1	0. 57	$1. 74
2. Feed dinky press: (a) Transport bales 160 feet to small temporary block near dinky by 2-bale clamp truck, while (b) 1 pull-down man positions bale on ball side and 1 hand trucker moves each bale 15 feet to the dinky press, and unloads it into dinky	1. 00	3	3. 00	4. 46
3. Remove compressed bales from main press: Hoist man moves bales by jib crane to buck bar	1. 00	1	1. 00	1. 00
4. Transport bales 400 feet to storage and store 5 bales high in cordwood stacks by two 2-bale clamp trucks	1. 00	2	2. 00	4. 90
Total			6. 57	$12. 10

The cost per 100 bales, then, for handling bales into, within, and out of the warehouse in this way follows:

Receiving cycle	$7.08
Compressing cycle	12.10
Shipping cycle	22.39
Total	$41.57

The labor requirements are 22.14 man-hours. If 50,000 bales are received, pressed and set back, and shipped by the handling methods indicated, the operation requires about 10,600 man-hours of labor and costs about $20,300.

Summary.—The three types of handling operations just discussed are summarized below:

Type of handling operations	Man-hours	Total labor and equipment cost
(1) Compressing on shipment:		
Receiving (see p. 65)	4. 07	$7. 08
Compressing-shipping (see p. 72)	5. 83	11. 60
Total	9. 90	$18. 68
(2) Compressing on arrival:		
Compressing-receiving (see p. 73)	8. 89	15. 89
Shipping (see p. 69)	11. 50	22. 39
Total	20. 39	$38. 28
(3) Removing from storage, compressing, and returning to storage:		
Receiving (see p. 65)	4. 07	7. 08
Compressing (see p. 74)	6. 57	12. 10
Shipping (see p. 69)	11. 50	22. 39
Total	22. 14	$41. 57

Under the conditions discussed, it is considerably cheaper, from the standpoint of the handling costs, to compress bales on shipment than at any other time. This general conclusion can be supported by many other types of examples. There are some situations, however, where there may be relatively little difference in cost between pressing on arrival and pressing on shipment.

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